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GEOLOGICAL SURVEY OF ALABAMA

EUGENE ALLEN SMITH, *State Geologist*

BULLETIN 18

PRELIMINARY REPORT ON THE CRYSTALLINE AND OTHER MARBLES OF ALABAMA

By
WILLIAM FREDERICK PROUTY, PH. D.
Professor of Geology, University of Alabama
Chief Assistant Geological Survey of Alabama

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LETTER OF TRANSMITTAL

To His Excellency,

Governor Charles Henderson,

Montgomery, Ala.

Sir:—I have the honor to transmit herewith the manuscript of a Report on the Crystalline and other Marbles of Alabama, by Dr. William Frederick Prouty, with the request that it be printed as Bulletin No. 18 of the Geological Survey of Alabama.

Very respectfully,

Eugene A. Smith,

State Geologist.

University of Alabama,
November 1, 1916.

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From the record of the daily observations of the gage readings at these places when extended through sufficient time, the calculations of available horsepower to be obtained from the different streams is made.

PREFACE

In the preparation of this Bulletin the author has spent in the field a portion of five summers, aggregating a little more than three months time. A greater part of this time was consumed in the mapping of the deposit. Because of the lack of an adequate base map, it was necessary to traverse many of the roads and spend much time in locating the marble exposures and the boundaries of the marble-bearing rocks.

The geological formations outside of the immediate marble area, as shown on the preliminary map, frontispiece, are put on from data previously gathered by the Alabama Geological Survey. These data have been, however, checked up, and in some cases revised.

The roads, streams and settlements outside of the immediate marble belt, as shown on the preliminary map, have been taken, for the nothern half of the map, from the old Talladega topographic sheet, with certain modifications, and for the southern half of the map, largely from recent traverses made by the United States Geological Survey Corps.

In the study of the marble deposit, hearty cooperation has been received from the various companies owning and operating quarries in the region, and from the citizens at large. Indebtedness is expressed to the officials of the Moretti-Harrah Marble Co., the Alabama Marble Quarries Co., the Eureka Marble Co., the Marble City Quarry Co., the Alabama Carrara Marble Co., and especially to the Alabama Marble Co., of Gantt's Quarry, for assistance in studying these deposits. Acknowledgment is gratefully made for articles furnished by Maj. J. S. Sewell, Vice-President and General Manager of the Alabama Marble Co., dealing with "Commercial Possibilities of the White Marble of Talladega County," and "General Notes on the Manufacture of Alabama Marble," which are published in this Bulletin; and for statement by the well-known sculptor, Mr. G. Moretti, concerning the value of Alabama white marble as a statuary marble.

In the preparation of the Bulletin, free use has been made of previously published statements concerning the Alabama marble deposits. These observations, however, have been limited very largely to the State Geologists, Prof. M. Tuomey, and Dr. Eugene A. Smith, and the late Assistant State Geologist, Henry McCalley.

For some of the full-page illustrations of the quarry and marble mill of the Alabama Marble Co., and of buildings finished in Alabama marble, the author is indebted to the Alabama Marble Co. The photographs illustrating the statues done in Alabama marble, were furnished by Mr. Moretti. The two pictures of the Mobile postoffice are from Brown's Art Gallery. The remainder of the illustrations are from photographs or sketches made by the author, with the exception of photograph of thin slides, which were taken by Mr. R. S. Hodges, Chemist of the Alabama Geological Survey.

Bulletin 521 of the U. S. Geological Survey, by T. N. Dale, dealing with the "Commercial Marbles of Western Vermont," has offered many suggestions used in the present publication and its pages are frequently referred to.

The constant interest and aid given by Dr. Eugene A. Smith in all phases of the report is most gratefully acknowledged.

Acknowledgment of further obligations for data furnished or help rendered is to be found in the text in the proper places.

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INTRODUCTION

VARIETIES OF ALABAMA MARBLE.

There are several varieties of marble in the State of Alabama both crystalline and semi-crystalline. The chief semi-crystalline marbles comprise the variegated and somewhat brecciated deposits of Middle Cambrian age in Shelby county near Calera (* and †); the gray and somewhat variegated marble, chiefly of Pelham age at Pratts Ferry, Bibb county (‡ and §); and other less important local deposits of marbleized Pelham, Subcarboniferous and Knox limestones. Of these the Pratts Ferry deposit alone has been in the past considerably developed.

CRYSTALLINE MARBLE DEPOSITS

LOCATION AND EXTENT.

The Crystalline marbles of the State are the only ones which are now being quarried. They are located in a long and narrow area extending through Talladega county and into the northern portion of Coosa county, a distance of approximately 35 miles in a northeast and southwest direction. The maximum width of this area which includes the marble-bearing rocks, is a little less than 1½ miles. Both extremities of the field are terminated by faults.

GEOLOGICAL SETTING.

The marble area is for its entire length on the western border of the Talladega phyllite (Ocoee), from which it is separated, for the most part at least, by a reverse fault. For much of the distance on the northwest side of the marble area are found

*McCalley, Henry, The Valley Regions of Alabama, Vol. II, pp. 513-514.

†Byrne, P., Marble Formations of the Cahaba River in Alabama, Transactions Engineering Association of the South, Vol. XII, pp. 48-59.

‡Butts, Charles, Bulletin U. S. Geological Survey, No. 470, pp. 287-289.

§McCalley, Henry, The Valley Regions of Alabama, Vol. II, pp. 498-499.

the deep red lands of the Knox Dolomite formation. Phyllites, whose age in some cases is Cambrian, occur locally on the northwest side similar in character to those on the southeast side of the marble.

FAULT-BLOCK CHARACTER.

The long, narrow area in which the marble occurs is in part a fault-block. The strike of its rocks is in many places different from that of the bordering areas.

AGE.

While there is no direct fossil evidence as to the age of the marble in any part of the field, the general thickness and the character of the associated rocks lead to the conclusion that the age varies in different parts of the field from Pelham (Chickamauga) through Beekmantown to Middle Cambrian.

THICKNESS.

The thickest deposits of marble are to be found toward the central and southwestern part of the field where at the present time the chief development of the marble industry is taking place.

TOPOGRAPHICAL CONDITION.

The position of the marble-bearing rocks is indicated topographically by a well-defined valley for the greater part of their course, but in a few places the valley is diagonally crossed by elevations which mark the position of more resistant rocks. These elevations form the few watersheds in the valley.

TOPOGRAPHY OF SURROUNDING ROCKS.

The phyllite area to the southeast rises to a considerable elevation above the valley. The dolomite lands to the northwest of the marble are also slightly elevated above the valley and frequently form broad, fertile, low tablelands on that side. The phyllite areas which occur on the northwest side of the marble are marked by sharp ridges. In one case the phyllite ridge runs parallel with the marble for nearly four miles, but in the other cases the phyllite ridges diverge from the marble and allow dolomite lands to intervene.

MARBLE VALLEY.

The occurrence of the Alabama marble wholly at low elevations in a well-defined valley presents a striking contrast to the occurrence of the Vermont marble deposits and also to the occurrence of many of the Georgia and Tennessee marble deposits.

NATURAL EXPOSURES.

Throughout the marble field there are very few natural exposures of marble and these occur only along the streams or where the rocks have been sharply folded or faulted. The fact that the marble in some of the earlier developed quarries proved very unsound is due to their location on these natural outcrops above the drainage levels, where fracture, due to the unusual disturbance, is greater than elsewhere and where weathering, due to the exposed position of the rock, has been abnormally great.

STRUCTURAL CONDITIONS.

The structural conditions in the marble area are such as would result from a shortening of the earth's crust, due to lateral pressure, with accompanying reverse faulting, minor folding, and shearing stresses. The reverse fault on the southeast side of the marble area varies considerably in throw. In many places the main fault is paralleled by a second fault a few hundred feet distanct to the northwest in the marble valley.

OFFSETS.

The general northeast and southwest trend of the marble valley is sharply altered in several places by offsets. The largest offset has a lateral displacement of the valley of over three miles and is caused by a combined fault and fold. In many places small offsets occur along nearly parallel oblique or dip faults.

DIP.

The dip of the marble is remarkably uniform throughout the field. It varies, as a rule, but little from 30 degrees and is in a general easterly direction.

SCHISTOSITY.

In most of the marble exposures there is evidence of shearing stresses. Slipping has taken place for the most part along the schist planes but in some cases the slips are evident in the marble itself, forming the so-called "reeds" of the quarrymen. This slipping in the marble is sufficient in one locality to render the marble distinctly schistose.

JOINTS.

Both tension and compression joints are well represented. In some localities the diagonal joints have a radiating character. In all exposures the marble is much more unsound at the surface on account of weathering.

There are several beds of marble usually separated by dolomite, but there has not been sufficient prospecting to allow the determination of the maximum thickness of the deposit.

DESCRIPTION.

The Alabama marble is usually described as a fine-grained, white marble. It exhibits more or less chloritic and talcose veining and clouding. The chief attractiveness of Alabama marble is due to its life and to its warmth of coloring. The white marble is for the most part a cream-white rather than a bluish-white, the more common characteristic of the Italian marble. The Alabama marble is, moreover, unusually translucent, in this characteristic resembling the famous Parian marble. A number of varieties of Alabama marble result from the different directions in which the blocks are sawed; thus banded, clouded, or nearly uniformly colored varieties result from cuts respectively at large angles, at small angles and parallel to the schist lines in the stone.

COMPARED WITH VERMONT AND GEORGIA MARBLE.

Alabama marble is slightly finer in grain than the Vermont and very much finer than the Georgia marble. The crystals are also very much interlocked as a rule, giving toughness to the stone but making it more difficult to saw than the Vermont marbles. The low absorption and high compressive strength and sonorousness which the Alabama marble pos-

sesses to a marked degree, are to be expected from the fine interlocking character of its grains.

CHEMICAL CHARACTERISTICS.

Chemically the Alabama marble is a very pure calcium carbonate. The chief impurities are silica and magnesia. Iron is usually very low. In most cases when there is a small amount of magnesia or a trace of it, its presence is to be accounted for by its occurrence in the chlorite or talc which furnish the coloring agents in the marble.

QUARRY METHODS.

On account of the more distinct bedding in the Alabama marble deposits than in either the Vermont or the Georgia, the method of quarrying in Alabama is considerably different from the method employed in either of these states and more like that in Tennessee. The blocks in all cases are taken out parallel to the bedding plane and also parallel to the main lines of unsoundness, whether this unsoundness is down the dip or oblique to it. It was the early practice in some of the quarries to run the channelling machines parallel with the dip irrespective of the direction of the main joints or "headers" but such practice has proven very wasteful.

TUNNELING.

In the quarry of the Alabama Marble Company, (the largest marble company in the State) tunneling is now being employed in order to secure the largest possible floor space with the least possible expense and at the same time to develop this floor space in the marble, deep in the quarry where unsoundness from weathering is at a minimum.

PERCENTAGE SOUND MARBLE.

It is not possible to secure as high a percentage of sound marble from the Alabama marble quarries as from the quarries of Vermont and Georgia, but the percentage of marketable stone can be very largely augmented by skillful quarrying, sawing and finishing. As the Alabama marble has many characteristics unlike other marbles it is commercially advantageous

to have the marble quarried, sawed and finished under the same management.

PRICE AND MARKET.

On account of the lower percentage of the marketable stone to be gotten from the quarry blocks, and the slightly higher cost of sawing and finishing, the Alabama marble must be sold at a slightly higher price than other competing marbles such as those from Vermont, Georgia and Tennessee, but despite this handicap in price the Alabama marble has a well-established and rapidly growing market as shown by its extensive use and popularity in many of the great cities in all parts of this country and in Canada.

POSSIBILITIES.

The demand for Alabama marble warrants the establishment of a number of large plants for quarrying, sawing, and finishing. These companies should have large capital in order to carry the development to a point where the profits will be substantial.

GEOLOGICAL FORMATIONS CLOSE TO THE MARBLE BELT WITH THEIR GENERAL THICKNESS AND CHARACTER

System	Formation	Character
Mississippian	Oxmoor (Floyd)	Dark colored shales and interbedded sandstone. 500′-1200′.
	Fort Payne	Cherty limestone. 0′-200′.
Devonian	Chattanooga	Black shale. 0′-100′.
	Frog Mountain	Sandstone. 0′-30′.
Silurian	Red Mountain (Clinton)	Sandstones, shales and iron-ore. 0′—
Ordovician	Pelham (Chickamauga)	Blue and gray limestone. 200′-1000′.
Cambrian	Knox Dolomite	Mostly dolomite and chert, some limestone beds. 2000′-5000′.
	Coosa or Flatwoods (Conasauga)	Mostly thin-bedded, blue limestones with thin shale parting. 800′-2000′.
	Montevallo	Shales, sandstones and Aldrich limestone. 800′-1800′.
	Weisner	Quartzite, conglomerate, sandstone and sale. About 2500′.
Precambian*	Talladega (Ocoee)	Largely a phyllite with some metamorphosed, coarser sediments. Thickness unknown.

*In one place near Erin, Clay county, carboniferous fossils occur in the phyllites of the Talladega (Ocoee).—Science, Vol. XVIII (New Series), pp. 244-246, 1903.

GENERAL DISCUSSION OF MARBLE

MARBLE DEFINED

The term marble is often used in the trade to mean any relatively soft rock which is capable of taking a good polish. Under this classification would be included such rocks or minerals as serpentine, alabaster, fuchsite, travertine, sodalite, etc. Technically speaking, a marble is a rock consisting mainly or wholly of crystals of calcite or dolomite, or a mixture of the two. The term is also at present largely restricted to such of these rocks as are mainly or wholly calcite. It is in this sense that the term marble will be used in this volume.

DOLOMITE

A typical dolomite has an equal number of both calcite ($CaCO_3$) and magnesite ($MgCO_3$) molecules. But these two molecules are capable of mixing in any proportion from 1-1 to a practically pure calcite. A great many of the purer and higher grade marbles have a trace or a very small percentage of magnesian carbonate.

PROPERTIES OF MARBLE

A good marble must be capable of taking a brilliant polish. Ordinary pure limestone does not have such capacity, while a crystalline limestone of the same chemical composition does. This brilliancy of polish is apparently due to the light effects on the surface of the rather uniformly crystalline particles. The more perfectly crystalline the rock, the more brilliant the polish of which it is capable.

GRAIN SIZE IN MARBLE AND IN LIMESTONE

If thin sections of the various calcareous rocks are studied under the microscope it will be observed that particles or grains out of which the rock is made differ greatly in size and character. The fine-grained limestones are made up of particles which are very minute, in many cases as small as .003 m.m. These show no crystalline character. From these very fine-

grained limestones there are all gradations up to the coarsely crystalline marbles with crystals 7 m.m. maximum diameter. In some of the more closely grained limestones one can observe scattered crystals of calcite in a background of fine-grained, non-crystalline calcite. Since there is a gradation between limestone and marbles, both in their crystalline character and polish, it is often difficult to tell to which class a certain rock belongs.

TWINNING IN MARBLE

In all true marbles (Plate I) there are to be found some twin-crystals. In a crystal which is not twinned there is the same arrangement of all its molecules. In a twinned crystal this is true for each twin portion, but each portion has been turned 180 degrees from the portion next to it. In some crystals there are several twinning bands, and in many cases these bands have been bent out of their natural positions by later movements in the marble.

CHEMICAL CHARACTERISTICS

CLASSIFICATION AND COMPOSITION.

Marbles are divided, in a chemical way, primarily according to the calcium or magnesium content, into calcite and dolomite marbles, and secondarily according to the most conspicuous impurity. A calcite marble with much graphite would thus be called a graphitic calcite marble. Although there is considerable range in the composition of workable marble, yet the restrictions in the amount of certain elements in them is rather marked. The following chemical analyses of various well-known, local and foreign marbles will illustrate their general composition and range of composition.

*Analysis of Carrara Marble, Italy.**

Silica (SiO_2)	not determined
Iron oxide and phosphoric acid (FeO, Fe_2O_3) (P_2O_5)	.25
Lime (CaO)	55.62
Magnesia (MgO)	.13
Carbon dioxide (CO_2)	43.77
	99.77

*Wittstein, G. C. Untersuchungen einiger weissen Marmorarten, 1851. Also Bul. U. S. Geol. Surv. 521, p. 14.

Analysis of white Norwegian calcite marble from Velfjorden, Troviken.†

Insoluble	.77
Ferrous oxide (FeO)	.085
Manganese oxide (MnO)	.0013
Lime (CaO)	55.63
Magnesia (MgO)	.32
Carbon dioxide (CO_2)	44.05
	100.8563

*Analysis of White Calcite Marble From West Rutland, Vermont.**

Insoluble	8.00
Alumina (Al_2O_3)	.39
Ferrous oxide (FeO)	.14
Magnesia (MgO)	trace
Lime (CaO)	50.79
Water (H_2O) at and above 105 degrees	1.01
Carbon dioxide (CO_2)	39.80
	100.13

Analyses of Two Tennessee Marbles.‡

	No. 1.	No. 2.
Insoluble	.07	....
Silicia (SiO_2)	....	.23
Lime (CaO)	55.28	55.59
Magnesia (MgO)	.46	.14
Iron oxide (FeO, Fe_2O_3)	.21	.08
Alumina (Al_2O_3)	....	.16
Carbon dioxide (CO_2)	43.87	43.76
	99.89	99.96

No. 1. Holston marble from quarry near Knoxville.
No. 2. Gray marble, Meadow Quarry.

†Vogt, J. H. L., Norsk Marmor, 1897, p. 19.
*Bul. U. S. G. S. No. 419, p 189.
‡Tenn. Geol. Surv. Bul. 2 D. p. 22, 1911.

Analyses of Georgia Marble.‡

	1	2	3	4	5	6	7
Lime (CaO)	54.06	32.73	55.00	31.53	31.61	54.41	30.42
Magnesia (MgO)....	.90	19.37	1.12	21.30	21.06	.75	19.86
Iron and aluminum oxide (Fe_2O_3, Al_2O_3)	.10	.35	.15	.24	.78	.32	.91
Silica (SiO_2)	2.12	.73	.35	.10	1.01	1.62	4.23
Loss on ignition......	42.86	46.58	44.16	47.26	46.49	43.13	....
	100.04	99.76	100.76	100.43	100.95	100.23	....

1. Coarsely crystalline white marble from the Cherokee quarry (Ga. Marble Co.), Pickens county.
2. White, fine-grained marble, from J. P. Harrison's quarry two miles east of Jasper.
3. Coarse-grained, black-and-white mottled marble "Creole," of the Georgia quarries.
4. Fine-grained, gray marble, from the Dickey property.
5. Fine-grained, bluish-gray marble, from the Holt property.
6. Coarse-grained, flesh-colored marble, "Etowah" of the Georgia quarries.
7. Fine-grained, black marble from Six-mile Station.

*White Dolomite Marble, Lee, Mass.**

Insoluble	.19
Iron and aluminum oxide (Al_2O_3, Fe_2O_3)........................	.24
Lime (CaO)	30.88
Magnesia (MgO)	21.42
Carbon dioxide (CO_2)..	46.72
	99.45

Analyses Chewacla Dolomite, Chewacla, Ala.†

	No. 1.	No. 2.
Insoluble	.40	.79
Iron and aluminum oxide (Fe_2O_3, Al_2O_3)........................	.19	.44
Magnesia (MgO)	21.13	21.16
Lime (CaO)	31.06	30.91
Carbon dioxide (CO_2)..	47.18	47.31
	99.96	100.61

No. 1. White coarsely crystalline dolomite from Mr. Young's quarry.
No. 2. Blue and less coarsely crystalline than No. 1 from Mr. Young's quarry.

‡Bul. No. 1. Georgia Geol. Surv., second edition, p. 109, 1907.
*By E. A. Schnider, described by Diller Bul. 150, U. S. G. S., p. 299. Analysis given in Bul. U. S. G. S. 419, p. 302.
†M. Tuomey, Geology of Alabama, Chap. I, pp. 53-54, 1850.

Average Analysis of Two Samples From Gantt's Quarry, Ala.‡
White Calcite Marble.

Silica (SiO_2)	.29
Iron and aluminum oxides (Fe_2O_3, Al_2O_3)	.10
Magnesia (MgO)	.19
Lime (CaO)	.55.71
Carbon dioxide (CO_2)	43.91
	100.20

*Average Analysis of 498 Constructional Limestones.**

Silica (SiO_2)	14.09
Titanium dioxide (TiO_2)	.08
Alumina (Al_2O_3)	1.75
Iron oxide (Fe_2O_3, FeO)	.77
Manganese oxide (MnO)	.03
Lime (CaO)	40.60
Magnesia (MgO)	4.49
Potash (K_2O)	.58
Soda (Na_2O)	.62
Lithia (Li_2O)	trace
Water combined (H_2O)	.30
Water uncombined and organic matter	.88
Phosphorus oxide (P_2O_5)	.42
Carbon dioxide (CO_2)	35.58
Sulphur (S)	.07
Sulphur trioxide (SO_3)	.07
Chlorine (Cl)	.01
	100.34

Pure calcium carbon contains 56.04% CaO and 43.96% of CO_2.
The calcium carbonate content of the above is only 76.18%. From this it is seen that the average limestone contains considerable impurity.

DISCUSSION OF CHEMICAL CHARACTERISTICS.

CALCIUM CARBONATE CONTENT

Calcite marbles usually have a calcium carbonate content of from 90 to 99% or more. The two chief impurities are silica and magnesium carbonate. These are always present to a greater or less extent. Most marbles contain less than 1% of iron oxide and the purer white marbles usually less than .10%.

‡Analysis made by Edmund H. Miller, Consulting Chemist, New York, 1906.

*By H. N. Stokes, Data Geochemistry Bul. U. S. G. S. No. 491, p. 583, Column H of Table.

MAGNESIAN CARBONATE CONTENT

The magnesian carbonate content of a marble may increase from a mere trace up to a point where the number of molecules of magnesian carbonate is equal to the number of molecules of calcium carbonate at which point we have an ideal dolomite containing 21.9% MgO, 30.4% CaO and 47.7% CO_2 or $CaCO_3$=54.35 and MgCO=45.65%.

RELATION OF IRON AND MAGNESIA

The amount of iron associated with a highly magnesian carbonate or a dolomite is apparently greater as a rule than that associated with a lower magnesian rock and in consequence the weathered products of the dolomite, as a rule, are deeper red than those from the rocks richer in calcite.

SILICA IN LIMESTONE AND MARBLE

The average analysis of 498 constructional limestones given above shows a much higher percentage of silica (SiO_2) and a lower percentage of calcium carbonate than average marbles. This difference is accounted for through the fact that in the recrystallization of the limestone into marble the impurities such as silica are largely segregated and in the quarrying and sampling the layers and masses of impurities are discarded. Then, too, not all limestones are sufficiently pure to make an acceptable marble.

IMPURITIES IN MARBLE

The impurities are not always detrimental. It is frequently due to their presence that the "life" or attractive "tone" of a marble depends. Most of the reds, pinks, and yellows are directly due to the presence of the oxide of iron. The green bandings and mottlings are frequently attributable to some form of the magnesian silicate such as talc, serpentine or chlorite. The gray and black markings are frequently due to graphite. The objection to, or advantage of impurities depends upon their nature, arrangement in the marble and their effect on the weathering or life of the stone. Pyrite for instance is exceedingly detrimental in marble used for exterior work as it oxidizes and stains the marble. Impurities with a greater

hardness than calcite stand out in relief on the polished surface to a greater or less extent and consequently tend to make the polish less perfect, and thin layers of such minerals as talc and chlorite, cause an easier splitting. Many of the impurities are secondary in their nature, that is they are minerals developed by a recombination, during metamorphism of the elements found in the original limestone. A limestone which has a considerable amount of magnesium in its constitution tends to yield a marble containing the magnesian silicate impurities.

PHYSICAL CHARACTERISTICS

CRYSTALLINE CHARACTER.

All true marbles are composed to a greater or less extent of crystals of calcite or dolomite. These crystals have a rhombohedral cleavage and are usually twinned (see Plate I). In some marbles the crystals are much interlocked (Plate I), while in others (Plate VIII A) this characteristic is nearly lacking. The size of the grain in common limestone varies from .05 to .003 m.m., while the size of the crystals in marble may reach ¼ inch in diameter.

TEXTURE.

The texture of the marble depends not alone on the size of the crystals, their uniformity of size, and smoothness or roughness of outline, but also on the manner of their arrangement, and, if the grains have differences of dimension, whether these differences of dimension have like orientation. In this latter case the marble tends to have an easy splitting direction or schistosity (see Plates XXVII B and III B). The texture may be further modified in the arrangement of minerals in the marble, the character of the bedding planes and slip planes, and their minerals. The following illustrate some of the more common differences of texture to be observed in marbles:

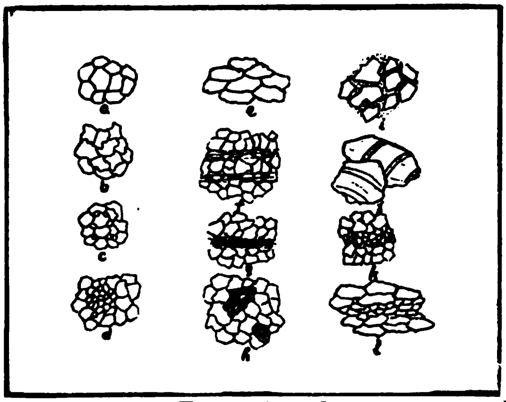

FIGURE 1. *a-l.*

a. Even grain, not interlocking.
b. Even grain, interlocking.
c. Uneven grain (irregular) large and small together.
d. Uneven grain (irregular) large and small separate.
e. Even grain slightly flattened with like orientation of flattened surfaces.
f. Banding due to color differences.
g. Impurities along bedding plane, as for example, chlorite, graphite, mica, etc.
h. Impurities irregularly distributed.
i. Breccia consisting of broken fragments.
j. Curved twinning planes, due to secondary movements.
k. Banded, due to different sized crystals in different layers.
l. Schistose structure in grain banding.

GRAIN SIZE.

Marbles are sometimes classified according to size of the grains. The table given below is one used by T. N. Dale in Bulletin 521 of the U. S. Geological Survey, showing the classification of the Vermont marbles into six grades as follows:

*Grain Diameter, In Millimeters.**

Grade.	*Maximum. size m. m.*	*Average size in m. m*	*General Average.* m. m.	*General Average.* Inches.
1. Extra fine	0.2	0.05–0.10	0.06	0.0023
2. Very fine	0.5	0.07–0.16	0.10	0.0039
3. Fine	0.75	0.10–0.25	0.12	0.0047
4. Medium	1.0	0.12–0.31	0.15	0.0059
5. Coarse	1.5	0.20–0.60	0.24	0.0094
6. Extra coarse	2.54	0.30–1.35	0.50	0.0196

*There are about 25 millimeters to the inch.

FRIABILITY.

The ease of working of a pure marble is largely dependent upon the texture. The grains or crystals of some marbles are easily torn apart, while in others that have interlocking crystals disruption is much more difficult. A marble with loose grains both saws and chisels more readily.

HARDNESS.

The hardness of marble varies greatly with the nature of its impurities. A pure calcite marble is three in hardness while a dolomite marble ranges from three and a half to four (most dolomites will readily scratch a coin while calcite marble is of the same hardness). The most common impurity in marble is quartz. This mineral may occur well disseminated, in which case the marble is made uniformly harder. More commonly, however, the quartz occurs more or less segregated and in such cases the marble is not capable of as perfect a polish as otherwise, since the quartz particles, being harder, stand out in relief.

COLOR.

Pure calcites or dolomites are either colorless or white. No marbles are absolutely free from coloring matter and the most common colors of the impurities are: gray, blue, and the different shades of red, brown and yellow. When the color of the marble is faint it is often difficult or impossible to determine the coloring agent, since the chemical test gives no evidence, and thin sections of such rocks studied under the microscope, appear perfectly transparent. But if the color is intense the coloring matter can usually be determined. Below are enumerated some of the chief coloring agents.*

BLACK

Graphite in minute scales, finely disseminated bituminous material.

GRAY

Graphite.

RED, PINK, REDDISH BROWN

Manganese oxide (MnO_2), or Hematite (Fe_2O_3), or both.

*See Dale's Commercial Marbles of Western Vermont, Bul. U. S. G. S. 521, p. 20.

BROWNISH YELLOW AND CREAM

Limonite, or hydrous iron sesquioxide.

GREENISH

Sericite, chlorite, epidote.

Some colored marbles such as the bright red, orange and blue lose color on heating. Other marbles are faded by bright sunlight. Many of the black marbles become gray on losing their polish through weathering.

SONOROUSNESS.

Some marbles when struck with the hammer ring under the blow, while others sound dead, or give little or no vibration. This quality of sonorousness is best tested by striking with the hammer a long slender piece of marble. The quality of sonorousness seems to depend very largely upon the closeness of grain, the closer the grain the more readily will the vibrations be transmitted through the stone and sound waves result. The Italian marbles are, as a rule, more sonorous than the Vermont marbles, and the Alabama marbles in general more sonorous than the Italian.

POROSITY.

The quality of absorption depends upon the pore space and the size of the pores. The pore space depends largely on the texture of the marble. A fine-grained marble may sometimes have more space between its grains than a coarse-grained marble, but the opposite is more often the case.

The degree of porosity is determined by immersing a block from which the water has been expelled by heat, in a colored solution a definite length of time and noting the depth of color penetration.

COMPRESSIVE STRENGTH.

The compressive strength, transverse strength and tensional or cohesive strength of marble depends largely upon the uniformity of the texture, the closeness of grain and the amount of interlocking of the crystals. Of these tests, that of the

compressive strength is more commonly made. The resistance to crushing perpendicular to the bedding is usually much greater than parallel to the bedding.

The following table shows compressive tests of a few of the better known marbles, in pounds per square inch:

	Perpendicular to Bed.	*Parallel to Bed.*
1. Coarse calcite marble, So. Dorset, Vt.	11,300	9,100
2. Alabama marble, Gantt's Quarry........	16,670	13,690
3. Common Italian	12,156	....
4. White Italian	21,788	....
5. Georgia marble	10,240–16,680	....

1. U. S. G. S. 521, p. 16.
2. Reihle Bros., Philadelphia, Pa., *Jan. 1906.*
3. Average two samples Tenth Census Report.
4. Average Tenth Census Report.
5. Sample from Kennesaw, Georgia and Southern Quarries, Geol. Survey Georgia, Bul. No. 1, p. 103.

DEFORMATION.

It is a well-known fact that marbles are deformed or flow under great pressure and heat without becoming fractured. This has been demonstrated in a number of ways. Adams and Nicholson* found by experiment on cylinder of marble enclosed in steel jackets (Figure 2) that with sufficient pressure marble can be deformed (Figure 3) and the resultant product show nearly as great or in some cases greater strength than the original material.

Julien† cites several instances of the deformation of marble. A notable case is that of an upright piece of marble 3.35 meters long and 22.8 centimeters wide and 6.35 c.m. thick in one of the doors of the Alhambra in Spain. Through settling of the wall this piece has attained a curvature of 76.2 m.m. (Figure 4).

*Adams, F. D., and Nicholson, J. T., An Experimental Investigation Into the Flow of Marble. Philos. Trans. Royal Soc. London, ser. A, vol. 195, 1901, pp. 363-401.

†Julien, A. A., The Durability of Building Stone, etc., Tenth Census of U. S. 1880, vol. 10, 1884, pp. 366-367.

It is a well-known fact that a long piece of marble supported at the two ends will slowly sag and become more and more depressed (Figure 5).

In region of folding the rocks are often completely folded and frequently a certain layer will be thickened or thinned by the deforming pressure without showing weakness in the layer so acted upon (Figure 6).

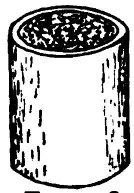

FIGURE 2.

Marble in steel jacket before compression.

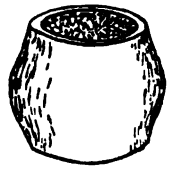

FIGURE 3.

Marble in steel jacket after compression. The strength of the marble is as great as it was before the experiment.

FIGURE 4.

An upright marble slab in door of the Alhambra in Spain deformed by overload.

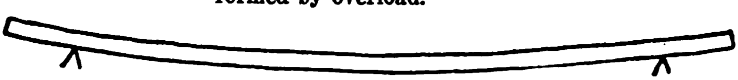

FIGURE 5. Illustrating the deformation of a marble slab which rested for many years on two supports near its ends.

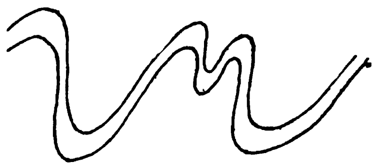

FIGURE 6. Showing the folding, thinning and thickening of a layer of limestone. This deformation was accomplished without weakening the limestone.

ACTIVE ELEMENTS IN DEFORMATION

There are three elements in the deformation besides pressure which must be considered, viz., time, moisture and heat. An increase in heat or moisture accelerates deformation for a given time, and a continuous though perhaps small pressure applied through a great length of time under ordinary heat and moisture, is capable of causing deformation.

DRAG-FOLDING.

It often happens in regions of lateral pressure, that the beds are shortened by this compression and at the same time are thickened. This thickening is often brought about by the so-called process of drag-folding. The evidence of this is often seen in the marble by the dissimilarity of bedding plane and schist planes, in other words blocks of marble taken out on the parting plane will sometimes have schist planes running through them diagonally. The two planes are thus seen to have the same strike direction but diverge or converge in the dip direction. Drag-folding as occurring on a large scale, is illustrated in Figure 18.

COEFFICIENT OF EXPANSION.

Government tests made at the Watertown, Mass., arsenal show the coefficient of expansion of marble to be:*

	Coefficient.
Marble from Lee, Mass.	.00000562
Vermont marble	.00000361

*Report on tests of metals, etc., at Watertown Arsenal, U. S. War Dept., 1895, p. 322.

TRANSLUCENCE.

The translucence of marble varies greatly and depends. seemingly, upon the properties of close grain as well as the transparency of the individual crystals. Of the Greek marbles the Parian is unusually translucent and some of the more attractive of the Carrara marbles have even a greater translucence, light penetrating as deep as 1.5 inches. Much of the Alabama marble is also very highly translucent, comparing favorably in this respect with the best Grecian marbles.

POLISH.

The property of a marble to take a polish is known to depend largely upon the degree of crystallization but many of the fine grained and only partially crystallized varieties give excellent polish, as for example the black marble from Calhoun county (Plate V B), and the semi-crystalline marble from near Calera (Plate IV A).

RELATIONSHIP OF DOLOMITE AND MARBLE

All marble was originally a non-crystalline limestone or dolomite and has reached its coarse grained character through crystallization. Since limestone and dolomite are the source of marble a study into their origin is not out of place.

ORIGIN AND NATURE OF LIMESTONE DEPOSITS

It is a well-known fact that limestones are being formed in both lakes and ocean waters. It is also known that limestones may form by chemical precipitation as well as by the accumulation of calcareous deposits from plants and animals. Since such is its origin, it is found in beds or strata which were originally about horizontal in position and have wide distribution and nearly uniform chemical character. This fact is of interest because of the bearing upon the distribution and continuity of the marble.

ORIGIN OF DOLOMITE

Dolomite occurs especially in the earlier geological formations in strata of great thickness and extent and is associated with limestone. The origin of the dolomite is yet an unsettled question. It is apparent in certain localities that it has been formed by the replacement of limestone after the stone has been elevated above sea level. There is locally strong evidence* that this replacement occurs in the yet unconsolidated limestone in the ocean. Some authorities† hold that original deposition, especially in the past, has played an extensive role in the formation of dolomite.

RELATION OF MARBLE AND DOLOMITE IN ALABAMA

In the Alabama marble deposits, dolomite beds occur of various thickness interbedded with the marble. The line of separation of these beds is usually a very sharp one as is shown by the microscopic study of thin sections cut through the contact.

*Evidence from drill core taken from coral rock Island of Funafuti, The Atoll of Funafuti, Royal Society of London, 1904.

†R. A. Daly, Bull. Geol. Soc. Am., Vol. 20, pp. 153-170.

If dolomite is a replacement product it is evident that there was a very marked preference shown by magnesian carbonate for certain layers. In these layers complete dolomitization occurred, while in the other layers no magnesian carbonate, or practically none, was introduced.

It is to be observed that the lenses and beds of dolomite are darker in color than the marble with which they are associated. This seems to be due frequently to the presence of a larger amount of iron in the dolomite and also to its less crystallized condition. It is to be seen in many places that the dolomite lenses are more broken than the marble enclosing them. This is due either to movement fractures, which fractures heal less readily than in the marble, or else to shrinkage fractures due to the formation of dolomite from limestone (dolomite having a greater specific gravity than limestone). That the dolomite was formed prior to the general thrust movement is evidenced at the Bowie Quarry where masses of dolomite have been occluded in the marble showing stratification or schist lines at various angles to the stratification of the marble (see photograph Plate XXIV B).

In the dolomite area to the west of the true marble belt some of the dolomites are interstratified with thin layers and lenses of pure high grade marble. An exposure, a little to the southwest of Gantt's Quarry, shows the conditions illustrated in Figure 7. In the region of Pratt's Ferry, Bibb county, some of these beds in the dolomite were quarried at one time a little to the west of the main Pratt's Ferry marble deposits.

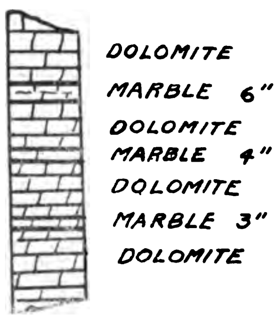

FIGURE 7. Showing thin beds of pure calcite marble interstratified with thicker beds of dolomite.

WEATHERING IN MARBLE AND ASSOCIATED ROCKS

RELATION OF TOPOGRAPHY, CLIMATE AND ROCK—CLASS

The surface relief of a certain region is usually very largely controlled by the kind of rocks of which it is made and their mode of occurrence, so that a study of the topography of a region is often a great aid to a knowledge of the kind and structure of its rocks. This is especially true in a country where the normal erosional agencies and disintegration are responsible, through selective weathering, for hills and valleys, as is the case in the southern part of the United States. The more moist and hot a country is, the greater is the chemical activity in the solution of its rock and the less active is the breaking down of rock due to frost action. As the result of this fact one would expect to find in the southern states what one actually does find, (Figure 8) that the valleys are formed in the more soluble, limy rocks, and that the hills are made of the less soluble. The farther north one goes the less confined to the valleys will one find the limestones and marbles. In many places, in Alaska for example, (Figure 9), the limestones form the highlands, and the sandstones and shales form the slopes and bottom lands. This is due to the greater breaking down of the loose grained rocks through frost action, and the greatly retarded chemical action in this cold climate.

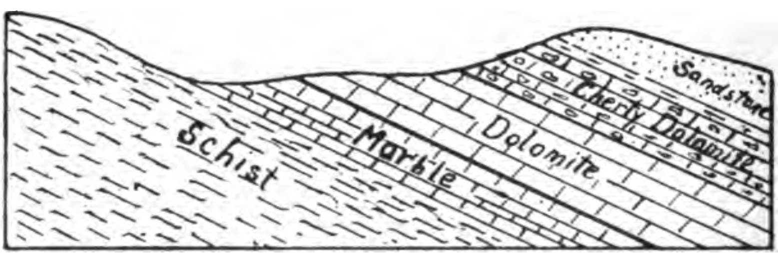

FIGURE 8. Ideal cross section through various sedimentary rock in Southern United States with monoclinal structure.

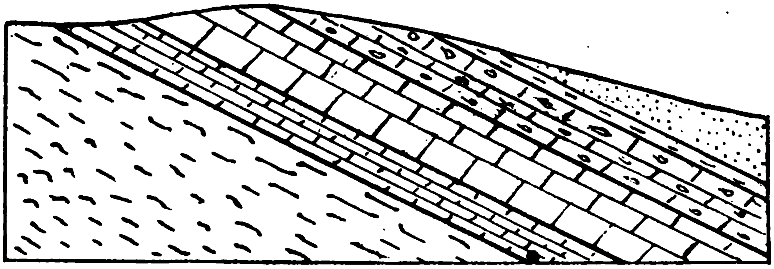

FIGURE 9. Ideal cross section of the same rocks as in Figure 8, showing difference of weathering in Alaska.

The occurrence of the Alabama marble wholly at low elevations in a well defined valley (Figure 12), presents a striking contrast to the occurrence of the Vermont marble deposits (Figure 10), and also indeed to the occurrence of many of the Georgia marble deposits (Figure 11). In the Vermont area many of the quarries are high above the drainage lines and there are large areas of outcropping marble on the slopes. In Georgia and Tennessee the same is true with the exception that the line between the marble and the overlying schist is at a relatively lower elevation on the valley slope. This difference of the topographic situation of the marbles of Vermont and Georgia is apparently in part due to the greater chemical activity in weathering in warmer climates, but in the case of the Alabama deposits this explanation is not alone sufficient. A comparative study of the cross sections through the different deposits does, however, supply the needed information.

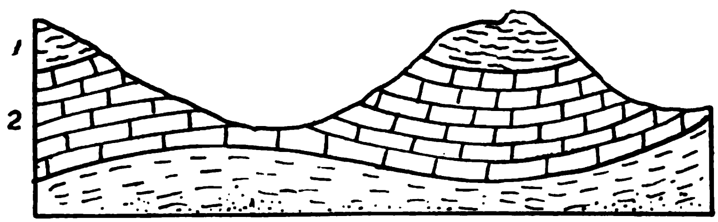

FIGURE 10. An ideal section showing the elevated contact between the schist and marble in Vermont. 1. Schist. 2. Marble.

FIGURE 11. An ideal section showing the less elevated schist-marble contact in Georgia than in Vermont. 1. Schist. 2. Marble.

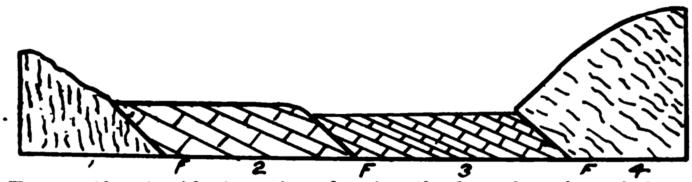

FIGURE 12. An ideal section showing the low elevation of the contact between the marble and the overlying schist in Alabama crystalline marble belt. 1. Schist. 2. Dolomite. 3. Marble. 4. Talladega phyllite. f. Fault.

The Alabama marbles (Figure 12) are separated from the overlying schist by a fault which provides a zone of more rapid solution than is the case in Georgia, where the climatic conditions are similar.

SOIL RELATIONSHIP TO PARENT ROCK

The character of the soil which the rock makes by decomposition is, within certain limits, characteristic of that rock. For instance a rock high in alumina and silica and low in iron will yield a rather light colored clay loam or sandy soil, while another rock low in silica, but higher in clay and iron content, will yield a deep red clay soil. The character of the soil, therefore, from a soluble rock will depend on the character and percentage of the various impurities which it has. It sometimes happens that a comparatively pure limestone yields a deep red clay soil. In this case the impurities were largely iron, alumina, and only a small amount of silica. It would take the impurities from a great many feet of such a rock to yield one foot of rock-waste or soil, while the decomposition of only a few feet of an impure marble would be necessary to yield a

foot of rock waste. Unfortunately the thickness of the soil above a rock is no definite criterion of its purity, as the amount of soil found above the rock bed depends on the capacity of the running water or wind to remove it, and it is often true that the rock with the greatest impurities, because it is less easily dissolved, is more highly elevated, and because of this high elevation the streams are able to carry off more rapidly the rock-waste and bring the rock bed nearer the surface.

SOIL COVER AND PROSPECTING

To use the character of the soil for prospecting, one must know either the general chemical analysis of the rock to be prospected, or he must be familiar with the soil actually derived from the rock in question. In case of determination by soil the possibility of the soil not being formed in place, but having been brought in by streams and spread out over the rocks in question, must be considered. Frequently the dolomite lands, which have as a rule a deep red soil, take on a much grayer surface color because of the concentration of sand, due to the washing away of the finer particles. This is especially noticeable in tracts which are practically flat and have not been recently plowed.

It is seen, therefore, that the condition of weathering in the Southern States, and the structure of the rocks in the marble deposits of Alabama, make it exceedingly difficult, because of their occurring in valleys with thick soil covering, and often with this soil transported, to tell from the surface indications exactly where the marble occurs; but, although the marbles are usually deeply covered, the character of the soil, the topographical conditions, and the association of other rocks, materially aid the man of experience in their location.

DRAINAGE CONDITIONS IN CALCAREOUS ROCKS

The drainage of soluble rock areas, such as those of limestone, dolomite, marble, etc., where streams have a well-marked gradient, is sure, in some places, to be partly underground. Often-times in such areas there will be districts in which surface streams occur only after heavy rains. The presence of underground drainage is told by the disappearance of

streams into the ground, and by the circular "cave-ins," or lime sinks. In such a country the underground water issues in lime springs often of great volume and clearness. The system of underground passages is often very extensive. Other things being equal, the sinks will occur most commonly in rock that is the most easily dissolved, or is more jointed or fractured, or covered with a more porous soil to give access of the surface waters to the rocks below.

Very frequently the outcrop of a particular bed can be traced by the line of sinks which occur in it. It has been the observation of the author that these lines of sinks occur most frequently on a line of contact between strata of different character, for example, a pure calcite marble and dolomite. It is an interesting fact that for the most part the large springs are located on lines of faults, and the larger ones are located at the crossing of faults. This does not necessarily signify that every large spring is on a fault line, but that as a rule, the larger springs are apt to occur along fracture zones.

MARBLE IN ALABAMA

GENERAL STATEMENT CONCERNING DIFFERENT MARBLES.

The sedimentary marbles of Alabama, like those of Vermont and Georgia vary considerably in age, texture, color, etc. In each region the main subdivision is based on the texture. We have, then, two great classes; A, the crystalline and B, the semi-crystalline. The onyx marbles (*usually cave marble*) are formed in an entirely different way.

In this State the crystalline marbles are the best known and are usually the ones referred to when Alabama marble is spoken of. These are the only ones which are being worked at the present time, although much prospecting is being carried on in the other belts.

The crystalline marbles are located in Talladega and the northern part of Coosa counties in a continuous belt about thirty-five miles long with a maximum width near Sylacauga of about 1½ miles. The age of the crystalline marbles in this belt is in places Cambrian and elsewhere Ordovician.

Semi-crystalline marbles occur in several geological periods in different parts of the State.

The variegated marbles near Calera of Cambrian age, occur below the chocolate shales of the Montevallo. Their occurrence is comparatively limited.

The belt of so-called "black marble" found in Calhoun, Etowah and St. Clair counties is apparently of Knox age. Local deposits of black marble also occur in the Pelham limestone at Pratt's Ferry and elsewhere.

The Bibb county deposits of marble exhibit some very attractive layers of Beekmontown and Pelham age. These deposits have been worked in the past with considerable success, but are not now being developed.

The marbles of Pelham age show locally characteristics very similar to those exhibited by the Tennessee marbles. They range in color from gray to mottled chocolate.

The sub-carboniferous limestones of the Tennessee Valley are locally marbleized. They include buffs and grays, which in some cases are very attractive. Samples have been received which are difficult to distinguish from the McMullen gray of the Tennessee deposits, the Alabama stone having markings of stylolites of similar character to those from Tennessee.

Most of the large caves of the State occur either in the Knox dolomite or the sub-coniferous limestone. The drippings from the roof, forming the stalactites and stalagmites, have accumulated in some caves in large quantities forming what is known as cave-marble or onyx-marble. As a rule the quantity of material thus deposited is not sufficient to warrant commercial exploitation. There are, however, a few caverns in which the deposits are sufficiently massive and free enough from impurity and small cavities to make them of commercial value, provided their development is conducted on a scientific basis.

THE CRYSTALLINE MARBLE AREA.

GEOGRAPHY AND PHYSIOGRAPHY

LOCATION.

The main marble deposits (the crystalline marble deposits), of Alabama occur in a more or less continuous valley which varies in width from 1/8 mile to 1¼ mile, and which trends in a general northeast and southwest direction for a distance of 35 miles, extending from about 33° 25′ north and 86° 1′ west, to about 33° 3′ 45″ south, and 86° 26′ 30″ west. Of this belt about 4 miles of the southwest portion is in Coosa county, the remainder is in Talladega county. The area probably extends to about 4 miles northeast of Taylor's mill, judging from the data now at hand. The southern limit of this belt is apparently about a mile a little north of east of Marble Valley postoffice. Here, as in the northern end of the field, marble is cut off by a fault. It is possible that there may be local occurrences of the marble further to the southwest along the valley of Crumply Creek and Pink Creek, but the author has not seen exposures of marble in this region with the exception of

the very thin layers of marble which occur interbedded with slate, of no commercial value, and which occurs in a belt usually found to the west of the marble area proper. Beyond the marble valley to the northeast the marble beds are cut out and the dolomite comes in contact with the Talladega phyllite. In a number of places along the fracture zone between phyllite and dolomite, workable deposits of brown iron ore occur.

TOPOGRAPHY.

We often hear the area of the marble bearing rocks spoken of as the marble valley. It is for the most part a valley. There are, however, marked exceptions to this rule, due to the fact already cited that the valley does not trend continuously in the direction of the strike of the rock, and that there are locally dolomite, and dolomitic chert ridges crossing the otherwise well marked valley.

At the southwest end of the field the slate hills, which converge to cut off the marble deposits, open up rapidly toward the northeast for a distance of about a mile, or to a little to the north of the Eureka White Marble Co.'s quarry. Northeastwardly from here the marble bearing strata are confined to the eastern side of the valley for some distance, as the dolomite comes in here between the diverging hill on the west and the marble on the east. About in the region where the marble crosses the Talladega-Coosa county line, and for a couple of miles to the northeast, the marble seems to be restricted to a narrow secondary valley from five to seven hundred feet wide, on the east side of the wide dolomite valley. In many places in this portion of its course there occurs, west of the marble depression, a well-marked line of fault boulders of chert, in places standing on edge to a height of 20 to 30 feet, (see photograph, Plate XXIX B).

A comparatively narrow slate ridge appears to rise out of the dolomite portion of the valley in the southeastern part of S. 14, T. 22, R. 2-E., near the residence of Mr. Walter Looney. This ridge nearly parallels the marble bearing portion of the valley, which is separated from it by a narrow strip of dolomite. This condition holds as far north as the Hamilton place, (Averiett Springs). From here northeastwardly the "slate" and marble diverge, and a greater width of dolomite intervenes

until a maximum width of the dolomite portion of the valley, 1¼ miles, is reached just to the northwest of Gantt's Quarry. Because of the simultaneous widening of the marble portion of the valley from about the county line to a maximum of 1¼ miles about on the western border of Sylacauga, the valley through here is unusually wide about 2½ miles. The dolomite portion of the valley, however, is somewhat more elevated.

Of the dolomitic and slate areas which diagonally cross the marble valley between the Hamilton place and the old Herd quarry northeast of Sylacauga, the one forming the ridge through the town of Sylacauga is perhaps the most marked, being about one-third of a mile in width. The marble valley gradually decreases in width to the northeast of Sylacauga with a local widening just to the east of the old Herd quarry in S. 23, T. 21 S., R. 4-E. After crossing the Tallaseehatchee Creek the marble valley is restricted to a well-marked depression between the Talladega phyllite on the east and a narrow ridge of similar rock on the west. This valley continues with a nearly uniform width of from five to six hundred feet, past the Alabama Marble Quarries located in NE. ¼ S. 1, T. 21 S., R. 4-E., and the Nix Marble quarries, located in S. ½ S. 36, T. 20 S., R. 4-E., until it is cut off by a diagonal fault about a mile to the east of Sycamore. From this point on to Rendalia no topographic depression marking the presence of marble is clearly defined. Northward from Rendalia there is a much better developed valley which varies, however, greatly in width from place to place.

DRAINAGE.

The streams which drain the marble bearing area named consecutively from the northeast portion of the field to the southwest portion, are as follows:

Kellys Creek.
Talladega Creek.

Tallaseehatchee and branches:
- Wewoka Creek.
- Emauhee Creek.
- Tallaseehatchee Creek.
- Crooked Creek.
- Shirtee Creek.

Cedar Creek.
Peckerwood Creek.

All the larger streams flow in a general westerly direction from the highlands of the Talladega phyllite area to the Coosa River. Many of the smaller streams run with the strike of the rock, (subsequent streams), and are the ones which have developed the valley in which the marble occurs. For the most part the divides between the streams which flow along the marble valley are low, allowing easy access of railroads to the valley as a whole. In many places the surface streams in the valley are only temporary on account of the rather extensive development of underground stream channels. This feature is most noticeable in the area where the marble valley has the greatest width. In the wide part of the valley east of Sylacauga, Crooked Creek is a permanent stream only in the region below the entrance of the valley springs. To the southwest of Sylacauga for about 11 miles, or to the crossing of Peckerwood Creek, there is not a permanent surface stream that flows for any distance in the marble valley. The greater part of the ground water of the marble area issues from bold springs in or on the border of the marble or in the dolomite region to the west of the marble, as for example, the springs near Herd Quarry from the marble; the Van Deusen spring near the east edge of the marble; the Sylacauga City spring and the Moretti-Harrah spring on the west border of the marble area; the Averiett spring, the Oak Park spring (Sylacauga), the Hill spring and the Ferris spring, in the dolomite to the west of the marble.

In many places it can be observed that there is a direct connection between the various sinks and springs, in both longitudinal and transverse directions in the valley, as for example the large sink near the L. & N. railroad in the NE. of the NE. of S. 29, T. 21, R. 4-E., in Sylacauga. This sink is known to be connected with the spring in Oak Park on the north side of the town. Also the pumping of water from the Moretti-Harrah spring has caused the formation of sinks about one-half mile distant, nearly across the strike.

It is apparent, I think, that the character of the drainage affects very materially the economics of the marble belt, and that with the beginning of the extensive development of the marble industry, the character of this underground drainage should be rather carefully studied.

Wherever the marble area is elevated above the general level of the valley, as is the case for most of the distance from the Hamilton place to a little north of Peckerwood Creek, the general ground water level stands at a considerable distance below the surface of the ground, and under these conditions the sinks and springs occur in the lower lying dolomite valley to the west. To the southwest of Peckerwood Creek the marble area again occupies the bottom lands, and has as elsewhere under similar conditions, a number of sinks and bold springs which furnish the water for the only permanent stream of the area.

AREAL GEOLOGY AND STRATIGRAPHY

ROCKS BORDERING MARBLE AREA.

The marble area is throughout its extent bordered on the east or southeast, by the Talladega "slate" formation, a phyllite or mica slate, (Ocoee formation of Georgia, Tennessee and U. S. Surveys). This boundary is generally well marked as the phyllite is resistant to weathering and forms considerable elevations toward the east. Throughout the greater part, and possibly throughout the entire length of the marble region, the marble is separated from the phyllite by a thrust fault. In some places this fault is parallel to, and in other places oblique to the strike of the rocks in the marble valley. It is also in places oblique to the phyllite, but as a general rule the two are parallel. Both the geological and topographic character of the country to the west of the marble area differ greatly in different portions of the belt. In places a phyllite occurs immediately to the west of the marble, as well as to the east, but for the greater part of the distance it is bounded on the west by a dolomite, giving deep red soil and forming flat or rolling land not greatly elevated above the level of the marble land bottoms, and sometimes on a level with them. The marble valley on the west as on the east, is for the most part bounded by fault.

Because of the fact that the dolomite occurring to the west of the marble is not always well defined topographically, and because also the dolomite beds in several places continue across the marble valley in a diagonal direction, it is not always easy to define the western limits of the marble-bearing rocks.

MARBLE AREA NOT ALL MARBLE.

The map which accompanies the report shows the general position of the strata which have in them locally workable marble. It is probable that some of the area included as marble-bearing does not have marble in workable quantities. It is also probable that some of the areas mapped as dolomite have thin beds of good grade marble in them, though such would be of no economic value. It does not seem advisable to attempt in this preliminary publication a detailed mapping of the marble beds which occur in the marble valley for the reason that without more development the getting of such information would be too expensive, and also on account of the hindrance to accurate mapping due to the lack of a good base-map.

TREND OF VALLEY.

As will be seen from the map (Frontispiece) the course of the valley is by no means a straight one. From the southwest end of the field the marble-bearing measures trend about in a north 40° east direction for a distance of about 6 miles. A rather sharp bend near Averiett Springs gives an almost east and west direction to the valley for some distance. From here on the valley gradually swings toward the north until at Sylacauga it has a direction of about N. 50° E., thence it pursues an almost northeast course until at about the Alabama Marble Quarries, 1¼ miles east of Emauhee station, the valley makes a sharp bend and continues in a northwesterly direction to a point about 1 mile east of Sycamore, where it is cut off and displaced by a combined buckling of the strata and fault. From north of Sycamore on to the northeast end of the deposit there are a number of small offsets caused by cross-faulting most noticeably at Bowie Quarry, also southeast of Berney Station and near Taylor's Mill.

NATURAL EXPOSURE.

In practically every place where the marble is naturally exposed much above the drainage level, it is found to have been faulted up. For example the old Herd Quarry, 2½ miles northeast of Sylacauga, the old Nix Quarries about 1½ miles

southeast of Sycamore, the old Bowie Quarry, 1½ miles southeast of Rendalia, and the Leak and McKenzie Quarries northeast of Taylor's Mill. In fact the only places in the whole marble area where marble is naturally exposed are where faults or sharp folds have brought the marble above the general level of the valley, or else where streams have cut down and exposed the marble in the valley floors.

AGE OF THE MARBLE.

While there is no fossil evidence in any part of the field to establish the age of the marble the general position and character of the associated rocks leads to the conclusion that the age varies in different parts of the field from Pelham (Chickamauga) through Beekmantown to middle Cambrian. According to Henry McCalley* the age of the marble to the northeast of Sycamore is largely of the bottom siliceous Knox formation with the exception of the quarries just northeast of Taylor's Mill which probably belong to the very top of the Coosa (Conasauga) formation, while to the southwest of Sycamore with the exception of the Herd quarry the marble is for the most part of Coosa (Conasauga) age.

THICKNESS OF THE MARBLE.

There has not been sufficient prospecting in the marble field to establish the maximum thickness of the marble deposits. The deposit as exposed in the quarries and by prospecting at the McKenzie openings, at the Nix Quarries and at the Alabama Marble Quarries near Sycamore, show the thickness of the marble at these localities to be at least two hundred feet (see section Figure 13). There are places in this northeastern end of the field where the marble is apparently much thicker.

The greatest width of the field occurs a little to the southwest of Sylacauga. In this portion there are apparently several beds of marble separated by low grade marble or dolomite. At Gantt's Quarry the condition is perhaps best known. Here a section made at right angles to the strike of the rock gives

*Report on the Valley Regions of Ala. Pt. II, pp. 589-598.

approximately the conditions shown in Figure 14. The present quarry is in the 175′ layer. There is here a known thickness of commercial marble in the two layers prospected of 400′ with a wide area to the east which very likely has additional workable deposits of marble.

The section (Figure 15) taken at right angles to the strike through the Moretti-Harrah marble quarry and across the marble valley shows a greater thickness of the unprospected measures than does the section through Gantt's Quarry.

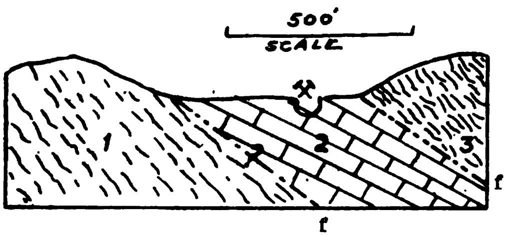

FIGURE 13. Section through the marble valley at right angles to the strike, just east of Enauhee station.
1. Phyllite similar to that on the east side.
2. White marble with opening of the Alabama Marble Quarries here.
3. Talladega phyllite.
f. Fault.

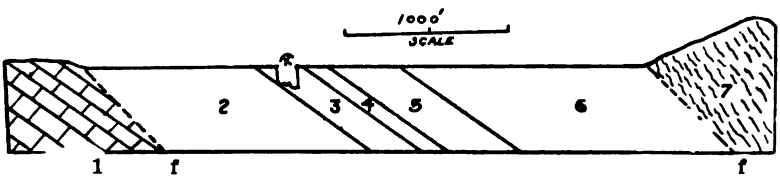

FIGURE 14. Cross-section through marble valley at right angle to strike, at Gantt's Quarry.
1. Dolomite.
2. Probably dolomite and marble.
3. White marble, 175 feet thick. Gantt's Quarry in this layer.
4. Blue low grade marble, too poor to work. 75 feet.
5. Mostly white marble, 225 feet.
6. Not prospected but probably dolomite and marble.
7. Talladega phyllite.
f. Fault.

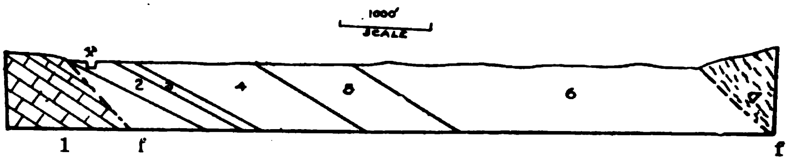

FIGURE 15. Section through the marble valley at right angles to the strike, about three-fourths mile northeast of the Gantt's Quarry section.
1. Dolomite.
2. White marble; quarry of the Moretti-Harrah Marble Co. in this layer.
3. Marble with considerable schist and some pyrite; not workable.
4. The lower seventy feet good marble; the rest is probably largely marble.
5. Dolomite, with some marble.
6. Unprospected; probably some marble.
7. Talladega phyllite.
f. Fault.

STRUCTURAL CONDITIONS

RESULTS OF LATERAL PRESSURE.

The marble is located structurally in the region where the earth's crust has been shortened by lateral compression, and in consequence of this, the rocks have been largely metamorphosed by the heat and the shearing stresses, resulting from this tremendous pressure. The shales have been changed into micaceous, slaty rock (phyllite). The limestones and dolomites have been recrystallized. Overthrust faulting has taken place and the fault-plane usually outcrops in the direction of the strike of the rock. Sometimes these reverse faults are compound, or roughly parallel to one another in the same belt. Along the fault there is considerable difference of throw, or vertical displacement, so that the same difference in the rocks on opposite sides of the fault is not always maintained. Moreover the overthrusting of the rocks from the east or the southeast by this compressive force has caused differential, horizontal movements, and the consequent bending of the measures now forming the marble valley from the usually northeast and southwest course. By this same action also the cross faults causing the jogs, or offsets in the marble valley, (more noticeable on the east side) were formed. The largest

offset causes a lateral displacement of the valley of over 3 miles, and is the result of a combined fold and fault.

The reserve faults most noticeable in the marble area are, 1st, the one separating the marble from the Talladega phyllite on the east. This is practically continuous throughout the length of the marble area, and has considerable difference of throw for different portions of the field. 2d. A thrust fault bounding the western side of the marble area for a large part of the field. 3d. Intermediate and parallel thrust faults which are more noticeable in places where the field has greatest development.

A fuller discussion of the faults will be found in connection with the description of the different divisions of the field.

DIP.

The dip of the marble strata varies from 25 to 45 degrees, but is usually about 30 degrees, and always in a generally southeast direction toward the Talladega phyllite.

FOLDS.

Small and local folds occur, but these are minor features in the structure of the field. The general strike and dip of the strata is but slightly modified by these minor foldings.

SCHISTOSITY.

In most exposures there is evidence of shearing stresses. Slipping has taken place most evidently along the bedding planes. Such stresses within the marble have for the most part been absorbed by the deformation of the crystals to suit the pressure without the formation of slipping planes. At certain localities, and in certain layers of the marble, there have, however, been developed decided slipping planes. These are sometimes spoken of as "reeds" by the quarrymen. Sometimes these reeds extend but a few inches before dying out, but in other beds they are much more extensive. At one locality in the field slipping in the marble is sufficient to render the marble distinctly schistose. Plate XXVII B shows hand specimen of such marble from the northern part of the field, and Plate III B shows photomicrograph of a slide taken from this specimen. The schistose character of this marble has been men-

tioned by Van Hise† and by Leith,‡ although the localities cited by them are incorrectly given as from Talladega Mountain, Alabama, and from Talladega Mountain, Georgia.

The direction of the shearing movements, as recorded in the slip grooves in the marble, is in most places nearly parallel to the dip direction. A microscopic study of thin sections of the marble cut in different directions in planes perpendicular to the bedding, also shows that the greatest elongation of the calcite crystals is parallel to the slip direction.

CRYSTAL FORM.

The character of the grains or crystals of which the marble is made reflect in no small degree the history of the rock, and also have a direct bearing upon the suitability of the stone for use as a marble. Whenever there is marked elongation of the crystals there is an accompanying greater ease of splitting of the marble in this direction, and unless the marble is sawed parallel to the grain its strength is somewhat lessened. It frequently is the case that the marble taken from the top or the bottom of the marble blocks, close to the more prominent bedding planes, shows a distinct elongation of the crystals, while at the depth of a few inches away from this plane in the block, this characteristic is not distinctly noticeable.

JOINTS.

Both tension and compression joints are represented in the marble. The compression joints which are oblique to the strike, are more often the more prominent. In some localities these diagonal joints have a distinctly radiating character, such as would result from torsional stress, (see Figure 16, showing Daubree's experiment). The torsional stresses might occur in case of unequal support of strata, or uneven distribution of resistance to the compressive forces. The nature of the jointing in one of the quarries as prospected by core drilling in which a double core barrel was used, is represented in Figure 17. In this figure the short direction of the rectangle is the strike direction, and the long direction is parallel with the dip. The lines represent the intersections of the jointing planes with

†Van Hise, Charles R., Monograph 47, U. S. G. S., pp. 810, 811.
‡Leith, C. K., Bulletin U. S. G. S., 239, p. 41 and plate 16.

the bedding plane. The dashed line represents the direction of the diamond drill core in the bed prospected. Three expansion joints "or slicks" ar to be seen close together near the center of the rectangle, parallel to the long direction. The few strike joints are apparently tensional joints, while the diagonal joints are the result of compression. The radiating character of some of these joints being due probably to torsional stresses. There are certain zones in the rock which are much jointed, and other zones which are relatively free from unsoundness. The jointing system here represented is the result of data gathered by core drilling the layer in question. This method has been used with success by Maj. J. S. Sewell of Gantt's Quarry. Figure 17 represents one of his prospect maps.

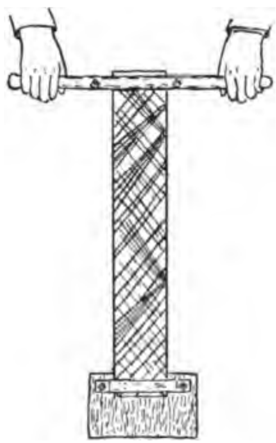

FIGURE 16. Diagram illustrating the development of rectangular joints, some of which are radiating, by torsional movement in brittle substance. After Daubree.

The method employed by Maj. Sewell in determining these jointing directions is briefly stated as follows:

The bearing of the bore hole is chosen to bisect the two dominant systems of jointing as nearly as possible. The end of the first core is marked before drilling begins, so that it is possible to tell which is the upper side and which the lower after it has been taken from the rock. The succeeding sections of the core are matched to the ones before by fitting the frac-

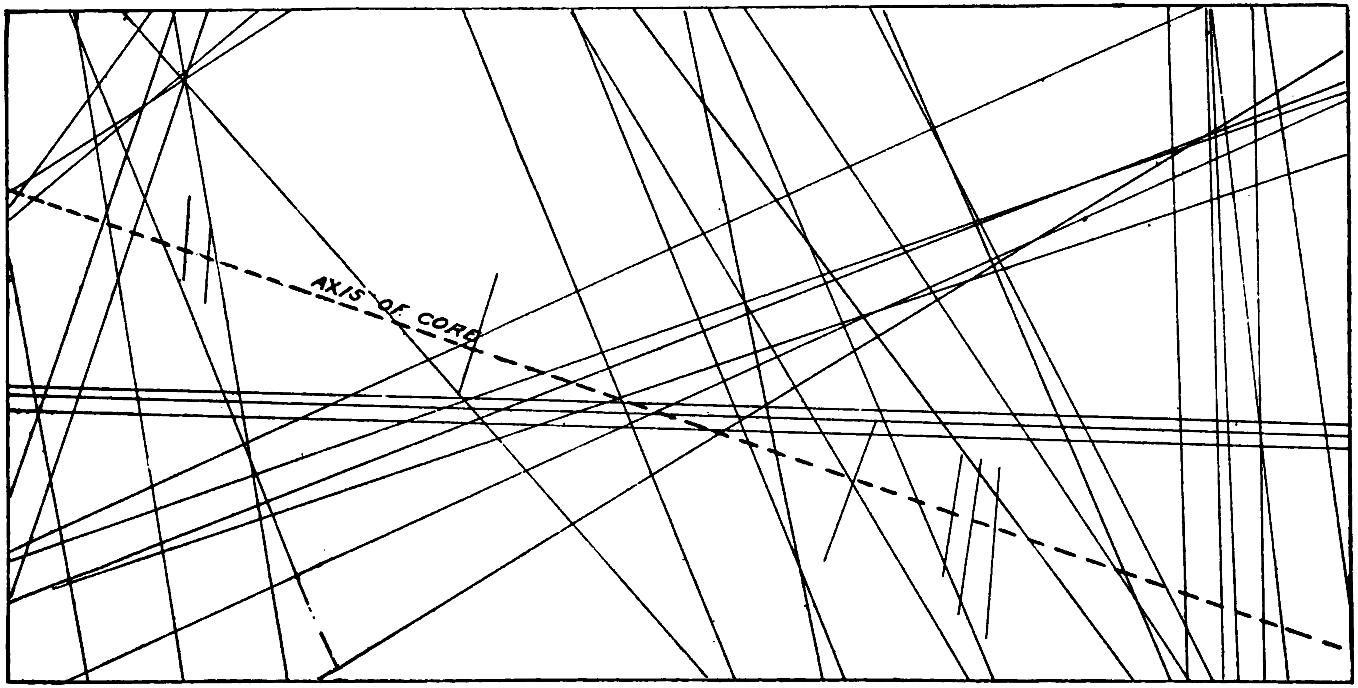

FIGURE 17. Represents the jointing in a portion of one of the quarries in the Alabama marble. The short direction of the rectangle is the strike direction and the long direction is parallel with the dip. The lines represent the intersections of the jointing planes with the bedding plane. The dashed line represents the direction of the diamond drill core in the bed prospected. Three expansion joints or "slicks" are to be seen close together near the center of the rectangle parallel to the long direction. The few strike joints are apparently tensional joints while the diagonal joints are the result of compression. The radiating character of some of the joints is probably due to torsional stresses. There are certain zones in the rock which are very much jointed and other zones which are relatively free from unsoundness. The jointing system here represented is the result of data gathered by core drilling the layer in question. This method has been used with success by Major J. S. Sewell of Gantt's Quarry, Alabama, and the above represents one of his prospect maps.

tures, or else by means of the grain in the marble. The core thus taken from the rock is laid out on the surface of the ground with the top side up, a rack is then built having its axis exactly the same in direction and dip as that of the bore hole. The core is then placed in this rack with the result that it now occupies the exact relative position it formerly had in the marble deposit. Since now every joint running through the core occupies its former compass position, it becomes a simple matter to draw on a plane, tangent to the upper surface of the core, the pattern of the joints. The error in the direction of joints recorded may be as much as 10 to 15 degrees. In recording the fractures very careful distinction needs to be made, and only the true joints and not the breaks due to the vibration of the machine should be plotted.

This plan of the jointing system brings out very clearly the fact that the diagonal joints at this locality are by far the most important. The plan also shows the distinct zonal distribution of the joints. Some areas at the crossing of these joint zones are badly cut up, while other areas, lying between these zones, are very much freer from unsoundness. This knowledge is of great importance to the quarryman in knowing how best to develop the quarry, and what to expect when developed.

DRAG-FOLDING.

Evidence of drag-folding in the marble is frequently seen. In one of the quarries many of the blocks which are taken out parallel to the general dip direction, show an angle of as much as 15 degrees between the minor schist lines in the block and the general bedding plane. (See Figure 18.)

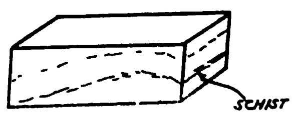

FIGURE 18. Showing schist lines in block of marble at variance with general bedding direction due, it is thought, to differential movements in the layer because of drag.

"SLICKS."

In all exposures the marble is much more unsound at the surface, due to weathering, than it is deeper in the deposit.

The chief agents of unsoundness in the marble in the upper few feet of the quarry, are the so-called "slicks," vertical planes of parting which run directly down the dip and decrease with depth. These lines of weakness are similar to the vertical joints which occur in concrete dams at right angles to their length, and which result from the expansion and contraction due to the changes of temperature.

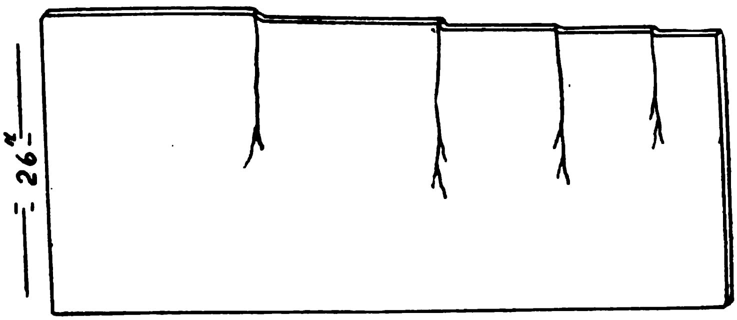

FIGURE 19. Represents a slab of marble cut from near the upper surface of a large block of marble taken from Gantt's Quarry. The surface of the block shows steps which are due to minor faulting. These lines of fracture when traced into the marble for some distance, gradually disappear, and it is thought that the rearrangement of the individual crystals along this fracture zone, gradually absorbed the difference of movement on either side of the fault plane so that the actual displacement or break disappears with depth. This characteristic of the dying out of unsoundness away from the surface, represents on a small scale, what is true on a large scale in the quarry. The unsoundness, due to weathering and to a small extent also to movements in the quarry, tends to become less with depth.

DESCRIPTION OF DIVISIONS

TAYLOR'S MILL DIVISION.

EXTENT AND EXPOSURES

This area includes that portion of the marble valley stretching from the northeastern terminus of the field to opposite Berney's Station, a strip about 9 miles in length. All the known exposures of marble in this division occur in a restricted portion between Taylor's Mill and the A., B. & A. Railroad. All these exposures are found on the northwest side of the valley and their outcrop is in each case partly due to a local disturbance or fold.

One of the four marble quarries which have been developed in the area is at the present time being worked. These quarries with their respective locations are as follows:

1. Lower Leak Quarry, (in SE. ¼ of S. 12, T. 19, R. 5-E.).
2. Upper Leak Quarry, (in SW. of NW. of S. 7, T. 19, R. 6-E.).
3. McKenzie Blue Quarry (E. ½ of N. ¼ of S. 7, T. 19, R. 6-E.).
4. McKenzie White Quarry (W. ½ of NE. ¼ of S. 7, T. 19, R. 6-E.).

All four quarries appear to be in the same lead of marble, although the openings are made on different beds in this deposit, giving to the different quarries distinctive coloring of the stone. This difference is most marked in the two McKenzie quarries, the one to the east showing a larger amount of white marble than does the one to the west, which has been operated mainly on light blue layers.

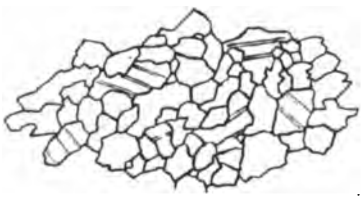

FIGURE 20. Marble from the Alabama Carrara Marble Company's quarry showing extreme interlocking character of crystals. This is perhaps an explanation for the toughness of the stone and its high sonorousness. Maximum grain .2 m.m.; minimum grain .02 m.m.; average grain .08 m.m. Magnified 50 diameters.

The character of the marble from all these quarries differs markedly from that of any other quarry in the marble area in having a less sugary (saccharoidal) and a more calcedonic texture.

The greater amount of blue coloring and the fineness of the grain of the marble from these quarries are probably due to the lessened action of metamorphism and the consequent lessened recrystallization in this portion of the field. It appears to be true that the more extended the recrystallization of any marble, the whiter will it become on account of the lessened dissemination of the coloring matter.

Marble slabs taken from the mill at the McKenzie quarries (see Plate XXXVI) show very high sonorousness giving sharp, clear sound when struck with hammer). No official tests of the physical properties of the marbles from this portion of the field have been made, but a careful study of the stone under the microscope, (see thin section, Figure 20) indicates that the strength and durability of the stone is unusually high.

The marble from these quarries has been considerably used for monuments, statuary, and wainscoting, and to some extent for exterior work, for which it is excellently adapted. The light blue variety is found to be exceptionally strong and free from cracks, and can be gotten out in large blocks. Its texture and color make it a novelty.

In some of the undeveloped marble exposures in this portion of the field, overthrust faulting and accompanying slipping of the marble, have given rise, locally and in certain of the beds, to well marked schistosity (Plate XXVII B), the calcite grains, as in Plate III B, being considerably flattened and elongated in the direction of slipping.

FIGURE 21. Elongation of the crystals is apparent as is also their interlocking character. Marble from quarry of the Alabama Carrara Marble Co. Magnified 50 diameters.

Of the two sets of joints those which run parallel with the strike direction are the most pronounced.

From a number of analyses it appears that the marble from these quarries is uniformly higher in silica than the marble from the quarries to the southwest of here. A microscopic study of thin sections, however, shows the silica to be well distributed through the marble, and in consequence it has slight effect on the polish of the stone.

Of the four quarries in the area only two have been developed in recent years, the McKenzie Blue and the McKenzie White quarries.

McKENZIE BLUE QUARRY

This quarry is located a little over a quarter of a mile northeast from the Upper Leak Quarry, with opening in the side of a small marble ridge. An anticlinal fold with north and south direction of axis passes through this quarry and gives diversity of strike. The quarry opening is for the most part in the blue layers of marble. The light-blue bed, lying below a white and above a dark-blue layer has been found to yield material of large dimension, free from unsoundness. From this layer Mr. Moretti carved the figures exhibited at the Jamestown Exposition. The color and texture of this light blue marble are both novelties, and the stone is very tough and durable.

A marble mill (Plate XXXVI) with saws and rubbing bed has been operated for some time until recently at the McKenzie Blue Quarry, the products being shipped from a spur of the A., B. & A. Railroad.

McKENZIE WHITE QUARRY

About 1,000 feet east of the Blue Quarry is the McKenzie White Quarry, with its opening chiefly in white layers of marble. This quarry has been little developed. It appears that the beds worked in the Blue Quarry are above the white layers here shown. The strata in the White Quarry are practically horizontal. The opening which is made in this quarry both above and below the thin white layer, shows most of the marble to be blue or white streaked with blue. The cream-white, crystalline layers are seldom more than 20 to 30 inches, not thick enough to be worked except as a by-product of the blue marble.

UPPER LEAK QUARRY

The opening for this quarry was made some years ago, but it has not been worked in recent years. This opening shows about the same marble as that exposed in the McKenzie Blue Quarry.

THE LOWER LEAK QUARRY

This quarry, like the Upper Leak Quarry, has not been worked in recent years, and never was extensively developed. The blue and white layers of marble are exposed here near the road, showing a steep dip to the southeast. Overlying the marble, apparently unconformably, occurs a dark blue limestone, dipping to the southeast with a much less angle.

THICKNESS OF MARBLE

The thickness of the marble deposit at the McKenzie Quarry is not definitely known. The borings made in the quarry reveal about 90 feet of marble, but the top layers of marble as exposed in the quarry, are separated from the slate ridge to the southeast by a narrow flat bottomed valley, which without doubt is in part underlain by marble.

SOUTHWEST OF TAYLOR'S MILL

For a mile or more to the southwest of Taylor's Mill there is a well-defined valley containing much alluvial soil. This valley is probably underlain in part at least by marble, though it is doubtless rather deeply covered. This valley grows narrower until about 3 miles southwest of Taylor's Mill it is almost pinched out by the converging slate hills. From this point on to the southwest the valley widens gradually to the point of offset directly southeast of Berney's Station.

McCalley* refers the marble exposed in this division to the top of the Siliceous Knox Dolomite. There is, however, no fossil evidence in the deposit, so far as seen, to make this correlation at all certain.

RENDALIA DIVISION.

EXTENT AND EXPOSURES

This division includes that portion of the marble area lying between the offset southeast of Berney's and the great offset of the marble measures at Sycamore, a distance of 6 miles. In this division there is one good exposure of the marble at the Bowie quarries and another very inconspicuous outcrop on the east side of Jack Mountain, just to the east of Ledbetter's.

*The Valley Regions of Alabama, Part II, p. 592.

No other exposures of marble are known to occur in this division and its presence is alone indicated by the topography and soil.

EAST OF BOWIE QUARRY

Just to the east of the Bowie Quarries there is an apparent offset of the measures. From here nearly to Rendalia the marble valley is not well defined, but between Rendalia and Berney's the valley becomes more distinct and increases in width.

Along the main fault line from the Bowie Quarries to east of Rendalia occurs a considerable quantity of brown iron-ore which has been pitted in many places. The occurrence of the ore here is similar to the occurrence of the ore in the neighborhood of Ironaton, a few miles to the northeast, where mining of the ore is active at the present time.

BOWIE QUARRY

In the Bowie quarries there is a bed of marble about 20 feet thick of very good color and grade with the exception that it is locally admixed with lenses and irregular occluded masses of dolomite.

The lower beds of the Bowie Quarry are dolomite with an occasional thin bed or lens of marble. Along the marble dolomite contact zone there is a considerable admixture of the dolomite and the marble, showing clearly that this has been a fracture and slipping zone with accompanying drag and occlusions. In the southwest of the two Bowie quarries where the marble bed is best exposed a thin bed or lens of dolomite overlies it. The presence of the dolomite above the marble suggests the possibility of the marble bed being similar to one of the marble beds known to exist in the neighborhood of Pratt's Ferry, some distance below the top of the Knox Dolomite formation; however, the valley immediately to the east of the Bowie Quarry suggests the presence of marble between the quarry and the Talladega phyllite.

Marble was successfully produced and marketed from the Bowie quarries for a number of years prior to the war, first by the Herd Brothers and then by Bowie, Oden & Co. Much of the stone from the quarries was transported over the old

plank road to Montgomery and Wetumpka. Since the war the Bowie quarries have not been successfully worked for marble. They are now the property of the Jenifer Iron Co., and at one time were extensively operated for fluxing material.

SOUTHWEST OF BOWIE QUARRY

To the southwest of the Bowie quarries toward Sycamore there is not in general a well-defined valley between the deep red lands of the Knox Dolomite and the phyllite hills to the east and it is very probable that the marble beds in this portion are locally entirely absent.

The small exposure of marble on the east slope of Jack Mountain may represent a thin bed of marble in the dolomite. The crest of Jack Mountain, (topographically above the marble exposure but stratigraphically probably below it), is held up by a great mass of very cellular, drusy, Knox chert nodules, resembling the Potosi chert.

OFFSETS

The offsets in the Rendalia Division of the marble belt trend northwest. The most prominent offsets northeast of the Bowie Quarry offset are found near and at the northern terminus of this division in S. 5, T. 20, R. 5-E. and in the NE. portion of S. 32, T. 19, R. 5-E. These offsets give a greater width here to the low-lying and possibly marble-bearing strata than elsewhere in the Rendalia Division.

SYCAMORE DIVISION.

EXTENT OF DIVISION

The marble valley which is so poorly defined between the Bowie quarries and the great offset of the valley at Sycamore, reappears at a point about one mile directly east of Sycamore on the south border of the fault. From this point on to the crossing of the Tallaseehatchee Creek in S. 14, T. 21, R. 4-E., the marble valley is comparatively narrow and sharply defined, lying between the Talladega phyllite area on the eastern side, and a prominent though narrow phyllite ridge of probable Cambrian age on the western side.

This portion of the marble area, of about 3 miles in length, I have designated as the Sycamore Division. The valley has a northwest-southeast trend from the northern point of beginning to near the opening of the Alabama Marble Quarries Co., in the NE. of S. 1, T. 21, R. 4-E., where the course of the valley gradually changes to a southwest trend for the remainder of the division. Just before reaching Tallaseehatchee Creek, the valley begins to widen and passes into the still wider portion of the marble valley lying to the southwest of Tallaseehatchee Creek, designated as the Herd Quarry Division.

NIX QUARRIES

In this Sycamore Division are found the two old Nix quarries, located to the northwest of Emauhee Creek in the NW. ¼ of SW. ¼ of S. 36 and in the SE. ¼ of SW. ¼ of S. 36, T. 20, R. 4-E., respectively, and also the recently developed quarry of the Alabama Marble Quarries Co., by Pace's Branch in the SW. ¼ of NE. ¼ of S. 1, T. 21, R. 4-E.

All three of these quarries are located toward the east side of the marble valley. The two Nix quarries are located on natural exposures on the slope of the east side of this valley, this natural exposure above the drainage being suitable for the early development of the marble industry when small capital only could be had and when large dimensional stone was not required. These quarries never received any great amount of development and have not been worked in recent years, due to the fact that sounder stone can be had in less exposed positions elsewhere.

The southwest of the two Nix quarries shows an exposure of about 60 feet of marble. Below this there are about 25 feet concealed, then there is a small marble exposure at the foot of the hill in the road. The upper few feet of the marble is blue, changing below to white and white with blue lines. (See photograph, Plate XXI B.) A considerable quantity of the lower portion of the exposure is a beautiful sugary textured marble.

The upper Nix quarry, about one-fourth mile northwest, has a less exposure of marble than the lower quarry, but the opening is made in the same upper layers of the deposit. In both quarries the overthrust, somewhat crumpled phyllite has the

appearance of conformity. In both quarries also the slip direction on the beds, is a little west of north, and the chief joints trend a little north of east.

The thickness of the deposit is apparently the same as at the Alabama Marble Quarries.

ALABAMA MARBLE QUARRIES

The Alabama Marble Quarries Co. has its opening at the bend of the marble valley along Pace's Branch in the SW. 1/4

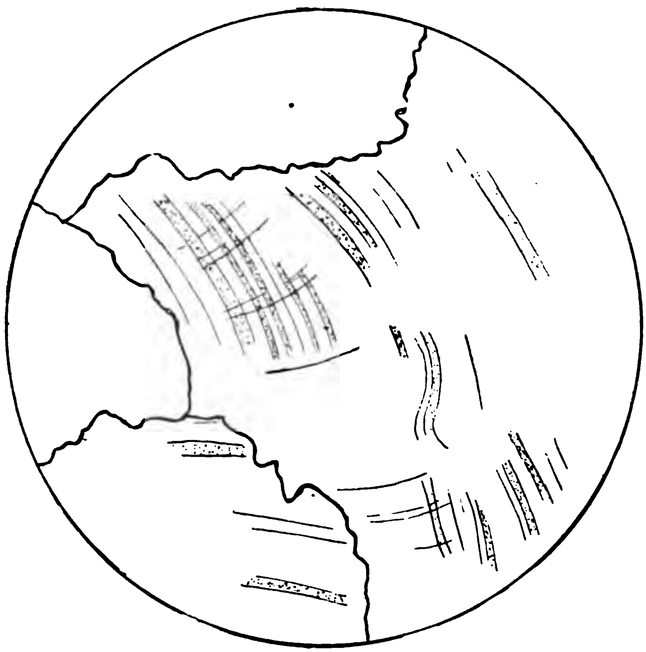

FIGURE 22. A sketch from another portion of the thin section photographed in Plate VI B showing curved twinning plains caused by secondary movement. Dolomite deposit, Tallaseehatchee Creek. Enlarged 50 diameters.

of the NE. 1/4 of S. 1, T. 31, R. 4-E. At this point the marble occupies the valley bottom and is covered by from 4-8 feet of soil. The main opening is toward the upper portion of the marble deposit on the east side of the valley about 150 feet from the marble-phyllite contact. This quarry has been con-

siderably developed in the last few years. Plate XVII shows the quarry in 1915. The marble is similar in its nature to the marble in the thicker deposits further to the southwest in the Gantt's Quarry district. Some of the beds in the quarry are exceptionally attractive in color. The chief source of unsoundness at this locality is found to be the "reeds" (or minor slipping planes more or less parallel to the bedding direction) which are common in some of the layers. The main joints run slightly diagonal to the dip direction. A core 103 feet in length, taken from the quarry and the marble below the layers in the quarry, shows the deposit in this part to be largely a cream white marble slightly streaked and banded with pale gray and blue coloring. The probable thickness of the marble in this division is about 200 feet. Siliceous lenses occur in some layers but that this is not general is shown by the core which in its entire length passes through but one thin siliceous layer.

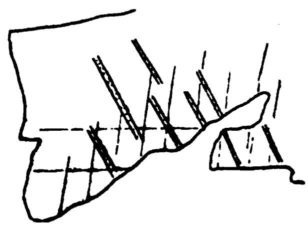

Figure 23. An enlarged sketch of a portion of Plate VI B showing the twinning bands cutting the cleavage rhombs in the direction of the short diagonal (characteristic of dolomite twinning). From dolomite deposit west of marble area at Louisville and Nashville Railroad crossing of Tallsaeehatchee Creek.

VALLEY TO THE WEST OF THIS DIVISION

Between the phyllite hill, which bounds the marble valley on the west through this division, and the Cambrian shale and sandstone hills, which carry the gray iron ore, lies a well defined, and in some places broad valley. The east portion of this valley is higher than the rest and is underlain by shale which in places carries thin bed of magnesian limestone, similar to the formation found in the ridge just to the west of Averiett Springs. The lower part of this valley, which is

best defined and broadest about Emauhee, carries for the most part dolomite, some beds of which, at least locally, are highly crystalline, light gray to white, and would seemingly make a very serviceable and attractive building stone. (Plate VI B shows photomicrograph of such dolomite from the L. & N. crossing of the Tallaseehatchee Creek.) Figures 22 and 23 also show characteristics of this building stone.

HERD QUARRY DIVISION.

EXTENT

Under this heading is included the area lying between Tallaseehatchee Creek on the northeast and the elevation passing diagonally across the marble valley through the southeastern portion of the town of Sylacauga on the southwest. The only development of marble which has taken place in this area is at the old Herd Quarry in the NE. of the NE. of S. 22, T. 21, R. 4-E., and in another quarry about a quarter a little north of west, frequently spoken of as the Hickman Quarry.

HERD QUARRY

The exposure of marble in the Herd Quarry is one of the few natural exposures in the marble area. It appears to be a fault block which forms a prominent knoll on the side of the slate mass to the east, and under which the marble dips at an angle of about 30°. The strike of the marble at this locality is about N. 60° E., and unless the strike of the marble changes considerably more toward the east, northeastwardly from here, which it does not appear to do, this particular marble bed must diverge from the slate hill which bounds it on the east at the quarry, and must extend out into the bottom lands a considerable distance to the northwest from the Talladega phyllite in the embayment which occurs a little to the northeast of the quarry. This divergence of strike of marble and line between valley and phyllite hill, suggests at this point a diagonal reverse fault between phyllite and marble.

Immediately below the Talladega phyllite in the Herd Quarry, occurs a dark blue marble for several feet. Below this layer, as seen in the quarry itself for about 60 feet, and in a core taken from the quarry for about 100 feet, the marble

has no heavy blue layers, but is white to white clouded, and white with blue veining. The general character of the marble is similar to that at Gantt's Quarry. It has a sugary texture, and a number of schistose (talcose) layers. The blue clouding is not a constant bedding characteristic, as the marble is found to become blue or white as seen in different places in the same bed.

As would be expected from the position of the quarry (the rock is unusually exposed to the weathering agents) and from the fact that the marble has been faulted up, there is much unsoundness in the stone, as is shown by rather numerous joints, slicks, and cutters. The thickness of the deposit at this quarry is not known, but the surface indications would lead one to believe that it is at least 200 feet, and probably more.

HICKMAN QUARRY

Immediately to the northwest of the Herd Quarry occurs a phyllite hill running parallel with the strike of the marble, and on the northwest side of this hill, about a quarter of a mile northwest of the Herd Quarry, is an exposure of marble. At one time this deposit was quarried and used for flux in the iron furnaces at Talladega. A railroad spur entered this quarry from the northeast along Crooked Creek. There are at this place about 30 feet of marble exposed with a strike of about N. 70° E., and a dip of about 25° to the southeast under the phyllite ridge which intervenes between the two marble quarries. The marble in this quarry appears to be the same as the top portion of the marble in the Herd Quarry just referred to. At the top there is the blue layer and below the whiter marble. In this quarry the contact between phyllite and marble is very well shown. This contact is a very irregular one (Plate XXII A), and there is strong evidence that the phyllite has been thrust-faulted over the marble, as is evidenced by slickensiding of the phyllite in the direction of dip, by fault breccia and by lenses of phyllite enclosed in marble near the contact.

As the valley extends from 4 to 5 hundred feet to the northwest of the Hickman Quarry across the strike before encountering a phyllite on the west side of the valley, it is thought that the marble underlies most of this area.

FAULTING

From the similarity of the marble in the Herd and Hickman quarries, and the presence of the phyllite hill between with similar strike, it appears that the measures are here repeated by strike faulting. This is further borne out by the fact that the phyllite hill which forms the ridge between the two quarries, dies out both to the northeast and to the southwest. The disappearance of this hill is accounted for by the decreasing throw of the fault, both to the northeast and to the southwest, so that the marbles which, in the locality of the quarries, are separated by the phyllite hill become again united. In the short course of this hill of about a mile, the hill has been offset by at least 4 nearly north and south parallel faults, two of which bound the Herd Quarry. (For probable conditions in this locality see Figure 24.)

NORTHEAST OF THE QUARRIES

Within a half mile to the northeast and east of these quarries, the valley opens out to the width of over one-half mile, due to a local southward embayment of the Talladega phyllite, previously mentioned. In less than a mile to the northeast from the quarry, or a little to the west of the crossing of the Tallaseehatchee Creek, the valley is again narrowed by the closing in of the phyllites, both to the northeast and southwest.

In the bottom lands between the Herd Quarry and Tallaseehatchee Creek, there are several exposures of marble. In the NE. of NW. of S. 23, T. 21, R. 4-E., a prospect pit shows a sugary marble with alternating blue and white bands. This marble has a strike of about N. 50° E. and a dip of about 30° E. To the east of this exposure about 100 feet, as I am told by an old resident, another exposure of marble with similar color could at one time be seen, which showed a strike direction a little more toward the north than the one just mentioned. In the N. ½ of S. 14, T. 21, R. 4-E. along Crooked Creek before it enters the Tallaseehatchee Creek, I am told there used to be several exposures of marble apparently similar to the marble last mentioned, and also like the marble which can now be seen on the west side of the marble valley at the crossing of the Tallaseehatchee Creek near the south line of S. 11, T. 21, R. 4-E. This is an exposure of sugary textured marble with bluish clouding and banding in a white background.

SOUTHWEST OF THE QUARRIES

About half a mile due west of Herd Quarry, or about a third of a mile southwest of the Hickman Quarry near Crooked Creek in the springy bottom land, can be seen a bluish marble, which is similar in appearance to the layer found immediately underlying the Talladega phyllite in both the Hickman and Herd quarries. From its location it is thought to be the same layer as that seen in the upper portion of the Hickman Quarry. It is also very probable that the springs at this point are caused by the issuance of the ground water along the plane of the strike fault above-mentioned.

The bottom land along Crooked Creek southwest from the quarries is apparently largely underlain by marble, as is also probably the case in the valley to the northeast of the quarries. The marble valley is approximately one-third mile in width for about a mile to the southwest of the Herd Quarry. At this point it widens on account of the dying out of a ridge of Cambrian "slate," which has a trend diagonal to that of the valley. Marble is known to occur in the bottom land in several places in S. 28, just to the east of Sylacauga. At the large spring in the SW. of the NE. of S. 28, T. 21-S., R. 4-E., it is approximately 9 feet below the surface and has an apparent strike of about N. 30°-E. Other pits in the NE. of the SW. of S. 28 also show marble at about the same depth as that at the spring. The material overlying the marble is apparently for the most part transported, as is shown by the material taken from the pits mentioned, which consists of gravel, sand and clay-loam. In one case a tree trunk was found at the bottom of the pit overlying the marble. The marble which occurs in these pits or springs is similar to that which occurs in the immediate neighborhood of the Herd Quarry, a white saccharoidal marble with some bluish bands and mottling.

At the Sylacauga City spring, in the NE. corner of S. 32, T. 21, R. 4-E., there is poorly exposed a somewhat siliceous layer of marble with strikes apparently in a northeast direction.

It can be said in general of the area lying between the Tallaseehatchee Creek and the hill which crosses the valley, cutting through the southeast side of Sylacauga, that there are, beside the two well-known quarries, sufficient exposures of the marble by pit or outcrop in spring or by branch to warrant

extended prospecting. It is thought further that the marble lying in the bottom lands apparently undisturbed by faulting, and protected by soil cover from weathering agencies, will be found much less unsound than that which is exposed in the Herd Quarry where weathering agencies have been most active.

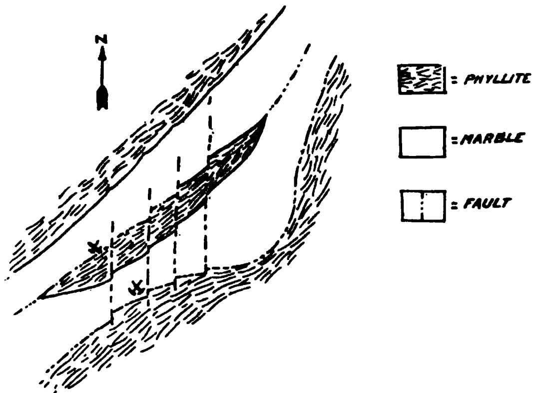

FIGURE 24. Probable structural condition near Hickman and Herd Quarries.

GANTT'S QUARRY DIVISION.

EXTENT

This division includes the area between the elevation passing through the southeast part of Sylacauga and the watershed in the marble valley just southwest of Gantt's Quarry. This division is over seven miles in length. In this division the area of the marble-bearing rocks reach their maximum width of a little over 1¼ miles.

CONDITION IN SYLACAUGA

The ridge which passes diagonally through Sylacauga with a N. 30° E. strike is apparently cut off toward the south side of the valley by a fault which runs parallel with the southeastern side of the marble valley. This diagonal ridge is apparently for the most part dolomite, but on its west slope several wells in the city of Sylacauga have exposed a good grade of white marble. This condition holds both in the NE.

of the NE. and the SW. of the SE. of S. 29, T. 21, R. 4-E. Marble is reported from other places within the city limits of Sylacauga, as for example near the L. & N. Railroad track by the cotton mill in the NE. of the SW. of S. 29, T. 21, R. 4-E., and near the Central of Georgia tracks in the SE. of the NW. of S. 29, T. 21, R. 4-E.

The large spring on the north side of town is in dolomite, but not very far from the dolomite-marble line.

Just outside of the city limits in the SE. of SE. of S. 20, T. 21, R. 4-E., and in the SW. of the SE. of S. 30, T. 21, R. 4-E., marble is known to occur in wells.

The marble underlying the central and southwestern portion of Sylacauga seems for the most part to be rather deeply buried. The well by the cotton mill is reported to have reached marble at a depth below the surface of 30 feet.

Samples of the marble from wells in Sylacauga are white to cream-white, saccharoidal, similar in texture and color to the marble now being so much quarried in this area.

On a hill just to the south of a colored church in the NW. of the SW. of S. 32, T. 21, R. 4-E., the marble has been uncovered by the roadside with strike approximately parallel with the south side of the marble valley. It is very probable that this marble has been brought up in a fault which runs parallel with a larger fault on the southeast side of the marble valley.

SOUTHWEST OF SYLACAUGA

Between Sylacauga and Gantt's Quarry the marble valley is for the most part nearly level, the exceptions being slightly elevated areas of somewhat deeper red soil, which have a general trend diagonally across the valley with a strike of about N. 35° E., while the strike of the valley through here is about N. 75° to 80° E. There is apparently much good marble underlying these flatter and lower areas. It is thought, however, that much of it is under rather heavy cover. There has been very little prospecting in the lands between the quarries in the neighborhood of Gantt's, and the wells which are above mentioned in the neighborhood of Sylacauga.

To the west of Gantt's Quarry the low land narrows and is completely cut off by a diagonal elevation about half a mile southwest of the quarry. This ridge forms a water-shed

which divides the streams flowing north and east through Gantt's Quarry from those which flow towards the southwest and west, (mostly underground) by Averiett Springs. It is probable that this more elevated portion carries a greater amount of cherty material and is more dolomitic in its nature than the rock forming the lower lands both to the northeast and southwest. In this portion of the area there are no exposures of marble.

In the Gantt's Quarry division we find the center of the marble industry of the State. There are two companies at the present time getting out and shipping marble in large quantities, and two other companies which have prospected and blocked out a large quantity of good marble. One of these companies has also opened a quarry pit on high grade marble preliminary to active operations.

ALABAMA MARBLE COMPANY

Location.

This company is the main producer in the State, with quarry and mill at the location of the old Gantt's opening in the NE. of NE. of S. 2, T. 22, R. 3-E. This location is about 2 miles a little southwest of Sylacauga, and is about a mile from the L. & N. Mineral Railroad, with which it is connected by spur track from Gantt's Junction. This quarry has been in active operation since 1904. There were early operations in the quarry for some years before the war by Dr. Gantt, a sculptor and quarryman. For a time also before the resumption of the more recent marble industry, marble from this quarry was used as a flux material in the nearby furnaces.

Development.

Quarrying operations have been chiefly conducted in the past from open pit, but at the present time the marble is being taken entirely from the two tunnels which have been put down with the dip along bed number three from the top of the quarry. This bed (see Plate XIII) is a line of weakness due to more active solution along an apparent thrust plane and has offered exceptional advantages in the construction of the development tunnels.

The purpose of tunneling is to give added floor space for quarrying at smaller cost, in higher grade marble, than could be done by stripping. This method of development by tunneling has been used successfully in many of the larger quarries, especially in Vermont.

Structural Conditions.

Toward the southwest end of the quarry there is to be seen a small anticlinal fold running diagonally across the strike. The origin of this particular fold is difficult to determine, and the time of its formation is also in doubt. There is, however, slightly more unsoundness in the marble affected by the fold which would suggest that the folding, or else the settling back of the marble along this folded zone, took place at a time later than the general period of metamorphism, or when the marble was in a less plastic state than we would expect it to be during recrystallization.

A study of the joint systems in the quarry, and the cores taken from the tunnels, show that there are two directions of rather constant jointing diagonal to the strike, as well as locally developed joints more or less parallel respectively to the strike and the dip. A notable character of the diagonal jointing is its tendency toward radiation. In some cases there is a divergence of as much as 30 degrees in the direction of these joints. This tendency toward radiation in the jointing of the rocks is suggestive of torsional movements in the quarry. (See Figure 17 for jointing conditions in a portion of the quarry.)

On account of the diagonal character of the jointing in the quarry, the marble at the present time is being taken out with the long direction of the blocks parallel to the diagonal jointing direction, instead of as was formerly done, directly down the dip. This new method of quarrying yields a higher percentage of sound blocks.

The strike of the rocks in Gantt's Quarry varies from about N. 50°-60° E. in the southwest end, to about NE. in the NE. corner. This change of strike is apparently due to the presence of the diagonal folds in the quarry. The slip direction, as is shown by grooves on some of the layers, indicates that the general direction of movement at the time of thrust faulting was N. 35° W.

A study of thin sections of marble taken from the slip zone, (see Plate I A), shows a slight elongation of the crystals in the direction of movement. The width of the zone in which the elongation of the crystals occur, is apparently narrow.

Local Character of Marble Deposits.

There are 15 beds which have been worked in the Gantt's Quarry deposit. These vary in thickness from 4 feet to 11 feet. The character of the stone varies somewhat in the different beds. The varieties of the marble depend chiefly upon two factors: the amount of the greenish, yellowish or grayish schist and the coloring of the marble itself whether cream white or bluish toned.

The quarrying operations and prospecting in the neighborhood of Gantt's Quarry shows the present quarry to be located in a stratum of more or less white marble of about 175 feet thickness, which is underlain by a bluish and more or less dolomitic deposit. Overlying this 175-foot stratum are to be found about 75 feet of inferior marble, and again overlying this 75-foot stratum is another workable deposit, the thickness of which has not yet been definitely determined, but the cores already taken out towards the southeast show it to be at least as thick as the deposit which is now being worked. There is moreover considerable space between the last prospect hole southeast of Gantt's Quarry and the phyllite hill. This space is probably in part occupied by marble.

The area northwest of the quarry has not been carefully prospected. There are one or two exposures of rock, however, which tend to show that this area is largely underlain by dolomite and interbedded marble of doubtful economic value. (See cross-section of marble area through Gantt's Quarry, Figure 14.)

Varieties of Marble.

The marble from the quarry of the Alabama Marble Co. is sold under several trade names which are dependent on the color or the pattern of coloring which appears on the surface of the sawed marble. These varieties are largely dependent on the manner of sawing the marble, whether parallel to, or at an angle to, the bedding direction and the lines of impurities, or "schist" layers, in the marble.

Use of Marble.

No marble from this quarry is sold in block form, but it is worked up in the finishing plants of the company for use in filling the contracts taken by the company.

Figure 25. An outline sketch from photomicograph plate I B to show the interlocking character of the crystallization and the character of the twinning bands. Due to this interlocking character the marble has comparatively high tensils and crushing strength and resistance to abrasion. Dotted areas are quartz. Enlarged 50 diameters.

MORETTI-HARRAH MARBLE COMPANY

General Setting.

The quarry of this company is located about three-fourths of a mile north 33° E. from Gantt's Quarry in the NW. of the NE. of SW. of S. 36, T. 21, R. 2-E. The quarry was opened in 1912 in the proximity of a bold spring which flowed from the marble, exposing it at this point. Operation of the quarry has been continuous since it was opened, and it is now being developed in an opening about 280 feet long and 90 feet wide. (See photograph—Plate XVI.)

A spur track, one-half mile in length, connects the quarry with the Louisville and Nashville Railroad. All the marble from this quarry is shipped to New York City in block form, and is loaded direct from the quarry to the car by derrick, or, in case the blocks are rough, they are first trimmed by means of a wire saw apparatus before they are loaded for shipment.

The electrical transmission line of the Alabama Power Co. passes directly by the quarry, as it does also by the other marble quarries in the southwestern part of the marble area, thus cheap electrical power can be had to take the place of the steam plants, or to be used as an auxiliary.

Character of Marble.

Marble in this quarry is of excellent grade. Much of it is a beautiful cream white, and is thought to correspond to some of the lower layers in the Gantt's Quarry of the Alabama Marble Co. (For photomicrograph of this marble see Plate II A.) This identity of the marble in the two quarries can be explained by a gradual change in the strike of the marble between the two quarries. This seems very probably the case, since the strike of the marble in the east end of Gantt's Quarry is about N. 40° E., and in the Moretti-Harrah Company's quarry about N. 28° E., with the bearing from the Gantt's Quarry to the Moretti-Harrah Quarry, as already stated, N. 33° E. The identity of these marbles could also be explained by an offset of fold and sudden change of strike somewhat between the two quarries.

Structural Conditions.

The dip of the marble in the Moretti-Harrah Quarry is slightly less than in the Gantt's opening, being on an average a little less than 30°. The jointing planes run for the most part with the dip and strike, but there are occasional well-defined diagonal joints which have a tendency to decrease the amount of available sound blocks taken out with cuts parallel to and perpendicular to the strike.

In some of the layers there is marked evidence of drag-folding. (See Figure 18; also Plate XXVI B.) This is seen in the arching of the lines of schist or color in the blocks. Frequently there is a difference of as much as 15° between the line of schist in the block and the apparent bedding plane, which is the plane of parting taken advantage of in removing the marble.

Neighboring Marble Land.

Prospecting has been done to the south and southwest of the present quarry, and a good supply of high grade marble is

known to be available. The soil cover through here averages from 5 to 7 feet in thickness, and is for the most part a buff-colored, more or less gravelly clay-loam which has been in large part transported by the surface streams.

Prospecting to the west of the Moretti-Harrah Marble Co.'s quarry shows that the marble is bordered in that direction by a dolomite similar to the one bordering the marble on the west at the Alabama Marble Co.'s quarry (Gantt's Quarry). To the southeast of the quarry the comparatively level land continues for a mile or more (see cross-section, Figure 15). To the east of this quarry is the property of the Marble City Quarry Co., whose land has been thoroughly core drilled, mention of which will be made elsewhere. Immediately to the south of the property of the Moretti-Harrah Co. a number of borings into the marble have been made on the property of Sidney Hiller.

MARBLE CITY QUARRY COMPANY*

LOCATION.

This company is located in the NE. of the NE. of the SW. of Section 36, T. 21, R. 3-E. The quarry opening of this company is immediately to the northeast of the quarry of the Moretti-Harrah Marble Co., being only a few yards distant across the property line. The opening is on the same layers that are being worked in the Moretti-Harrah Marble Co.'s quarry.

CHARACTER AND THICKNESS OF MARBLE.

At the present writing only enough blocks have been taken out to demonstrate the character of the marble which is similar to that in the other quarries located on these beds, but extensive core drilling of the tract to the east of this opening and to the east of the Moretti-Harrah Marble Co.'s quarry has been carried on with the result that a large amount of high grade marble has been blocked out. The marble for the most part in this immediate area is about 8 feet below the surface though in places erosion is much deeper, especially is this true in the area not far from the stream which passes through this and the adjoining property. Prospecting on this property with diamond drill and quarry opening reveals four divisions in the

*The Madras Marble Co., of 120 Broadway, N. Y., has recently taken over the holdings of the Marble City Quarries Co.

marble: a top, high-grade marble whose upper limit has not been determined, 75 feet; second a layer of marble with more chloritic schist and some pyrite, about 75 feet; third a layer of high grade marble in which the quarry is opened, about 130 feet; and fourth a lower layer into which the drill passed about forty feet and which carries considerable schist. Analyses of the marble from the first third and fourth layers are as follows:

	a	b	c
Silica	0.45	0.27	0.27
Alumina	Trace	Trace	Trace
Iron oxide	0.05	0.05	0.05
Lime CaO	55.01	55.12	55.16
Magnesia MgO	0.42	0.27	0.39
Sulphuric anhydride	0.01	0.01	0.02
Carbonic CO_2	43.28	43.30	43.40

a. First bed of marble sample taken from core from 37 feet below surface to 50 feet below surface exclusive of the schistose bands.

b. Third bed of marble, sample taken from core 74 feet to 99 feet below the surface, all inclusive.

c. Lower layer of marble, sample taken from core from depth 69 feet to 83 feet below the surface, all inclusive.

The above analyses taken from the report on the marble property by Ricketts and Banks, shows the marble to be exceptionally pure. The cross-section (Figure 15) applies to this area.

AVERIETT SPRINGS DIVISION.

EXTENT

This division includes the portion of the marble belt lying between the watershed just to the southwest of Gantt's Quarry, and the sharp bend in the marble deposits just southwest of Averiett Springs on the line between range 2 and 3, a distance of about four miles. For this portion of the marble area the valley trends nearly east and west and is approximately a half mile in width.

STRUCTURE

The fault block character of this division of the marble area, like the Gantt's Quarry division is very evident from the nonconformity of the strike of the rock in the valley and the trend of the valley.

The shale and sandstone formation, which is more than a mile distant from the marble valley in the neighborhood of

Gantt's Quarry, approaches the marble belt closely at Averiett Springs. See map frontispiece.)

The probable structure of this division is suggested by the faint lines running through the light shaded marble area on the map of this region.

MARBLE OCCURRENCES

Some of the higher elevated portions of this division are known to be underlain by dolomite, or dolomite and marble interbedded, (see Figure 7 for such conditions from sink in NW. of SE. of S. 4, T. 22-S., R. 3-E.), while the bottom lands are thought to be largely underlain by marble. The only locality in this division where marble has been exposed is in the general neighborhood of Averiett Springs on the present Hamilton place. Here a little northwest of the center of the NW. ¼ of S. 7, T. 22, R. 3-E., is a beautiful sugary textured, white marble exposed in the bed of a small branch. A prospect pit about 20 feet west of the exposure in the branch also shows the same kind of marble. Henry McCalley in his report on the Valley Regions of Alabama, Vol. II, p. 589, makes reference to the marble here mentioned in the branch. About 700 feet S. 70° E. from this exposure in the flat land near a lime sink, another prospect made by the owner of the land, shows a good grade of marble with strike as nearly as could be told from small exposure, N. 55° E., and with dip of 35° E. There is also reported to be marble in an old pit just above the crossing of the branch by the old Sylacauga road about in the center of the southern half of the SE. ¼ of S. 6, T. 22-S., R. 3-E. A prospect pit was put down to a depth of 17 feet in the center of the NE. ¼ of S. 7, T. 22, R. 3-E. without getting through the surface mantle of loose drift from the phyllite hills just to the southeast.

This division has been little prospected for marble, but the indications are excellent in a number of places.

DRAINAGE

There are numerous sinks in this division through which the surface waters get into the underground drainage. This explains the absence of surface streams for the greater part of the year in this area. The underground drainage of this divi-

sion largely comes to the surface at the Averiett Springs, which is located on the west side of the marble area, or from other springs in the same general neighborhood. (See Plate XXX B for the size of stream flowing from Averiett Springs in the dry season.)

WATTERS DIVISION.

EXTENT

From the sharp bend in the marble valley, about one-half mile southwest of the Averiett Springs, to the crossing of Peckerwood Creek, (about 4 miles), the trend of the marble-bearing area is due southwest. The width of the marble-bearing rocks in this division is seldom more, and usually much less, than a quarter of a mile.

TOPOGRAPHY

In portions of this division the area is topographically marked as a secondary valley on the eastern slope of a large dolomite valley. Just before reaching Peckerwood Creek its elevation becomes that of the general valley.

PROSPECTS

In the Watters Division there are no natural outcrops of marble, and its presence is only inferred from the topography and from its reported occurrence in some of the wells on the Watters property in S. 23, T. 22-S., R. 2-E. In these wells, however, the marble was reported to be 60 feet below the surface. From the relationship of the phyllite on the east, it is probable that the marble in this area is for the most part deeply buried.

WEST BOUNDARY FAULT

In places the boundary fault on the west side of the marble was marked by massive chert boulders. In one place, SE. corner of S. 14, T. 22-S, R. 2-E., these boulders can be seen standing some 30 feet or more above the general level of the country (Plate XXIX B). This phenomenon of massive chert boulders along the fault line, has been noted elsewhere in the region where the fault has involved the siliceous Knox Dolomite.

EUREKA DIVISION.

EXTENT

Under this division is included all the marble belt southwest of the Watters' Division. This portion of the marble belt is nearly three miles long and has a maximum width of about one-half mile. The marble valley is terminated at the southwest by converging faults, in the SE. corner of S. 14, T. 24-N., R. 16-E.

BORDERING FORMATIONS

From Peckerwood Creek for about a mile to the southwest, the marble is bordered on the northwest side by deep red lands, probably carrying dolomite in large part. From this point on to the southwest the fault is ordered on the west by phyllite of probable Cambrian age which appears identical with the phyllite on the east side of the marble valley.

NATURAL EXPOSURES

This division contains only one quarry but marble has been pitted or occurs in natural outcrops in a number of places. The most conspicuous natural outcrop of marble in this division is to be seen just to the southwest of the quarry of the Eureka White Marble Co. Here for a distance of 150 feet or more a beautiful white marble can be seen in the bed of the branch and in the E. of the SE. of the SW. of S. 12, T. 24-N., R. 16-E. (Plate XIX A). Two other exposures in the SE. corner of the same forty can be seen. These show a lower grade marble and also have a different direction of strike. Near the southwest terminus of this division and not far from the church and the bold lime spring in SE. of NW. of S. 13, 2. 24-N., R. 16-E. on the Darden place are several outcrops of banded, blue and white marble. This marble is usually not more than three or four feet below the surface of the floodplain of the little branch along which it is exposed.

STRUCTURE

The strike of the rocks on the western border of this division, for the most part, makes a considerable angle with the trend of the marble valley.

There is strong evidence in this division, as there is also in other divisions, of a fault occurring some distance in from the southeast boundary fault and parallel to it.

THE EUREKA WHITE MARBLE COMPANY

Location of Quarry.

The quarry of this company is located near a branch of Peckerwood Creek at a point just northeast of the natural exposure of marble in the branch referred to above, in the NW. of the SW. of the SE. of S. 12, T. 24-N., R. 16-E. This quarry was opeend during 1911-12 by the Bishop Marble Co., and a few blocks were taken out, but on account of not having a railroad to the quarry operations were halted. Under the present management a spur track has been built from the Louisville and Nashville Railroad, and the quarry considerably developed.

Soil Cover.

In the half acre uncovered for the quarry the marble was found at a depth of from 5 to 6 feet below the surface. The covering material seems to be largely transported, and is a yellowish sandy clay with irregularly shaped, more or less cavernous quartz pebbles one-half to two inches in diameter. These quartz pebbles are much more numerous toward the bottom of the mantle rock and frequently make a solid layer from 6 to 12 inches thick over the marble.

Character and Thickness of the Marble.

There is approximately 80 feet of marble exposed in the quarry opening. None of the layers in the quarry are deep blue but there is some cream white and a large amount of white with a faint bluish tone. The quantity of "schist" in the marble here is small but there are occasional small inclusions of dolomite masses or lenses which are darker in color than the marble and also much broken. These do not occur in sufficient quantity to be of any great detriment to the marble but their occurrence is of geological interest. If these lenses were originally deposited as dolomite they were less affected by the agents of metamorphism and were fractured by the movements which took place in the marble. If on the other hand it is as-

sumed that these lenses are due to secondary replacement, then their fractured character points either to some movement since their formation which was more felt by the dolomite than by the calcite, or else we must assume that the cracks in the dolomite are due to shrinkage in the change from calcite to dolomite. From the facts in hand it does not seem possible to determine the origin of these lenses.

The jointing directions in the marble are chiefly N. 75°-80° W. and N. 45° E., respectively, with the first-named set the more prominent. The strike of the marble in the quarry averages about N. 45° E. and the dip is about 35° E.

After a concealed interval of about ninety feet below the marble exposed in the quarry, there is to be found in the small branch to the northwest of the quarry an exposure of light colored dolomitic rock a few feet in thickness. Underlying this as seen down the branch toward the north for a distance of about 200 feet, occurs a dark blue magnesian limestone. This is in contact with a crumpled phyllite having an east and west strike.

To the southeast of the quarry, flat lands continue for more than a quarter of a mile. A well about three hundred feet to the southeast of the quarry has good marble in it. To the northeast of the quarry for three or four hundred feet prospect pits expose good marble at shallow depth.

Throughout this division there are a large number of lime sinks.

BIBB COUNTY MARBLE

LOCATION.

The semi-crystalline marble of Bibb county has long been known, and in the past considerably worked in a few localities. The chief locality of this early development was in the main deposit in S. 32, T. 24-N., R. 10-E. This locality is on the Cahaba River near Pratt's Ferry (see sketch map, Figure 26). At this point prominent bluffs of marble form the right (the northwest) bank of the river for three-fourths of a mile, beginning about one and one-half miles below the present bridge at Pratt's Ferry. On account of the bend in the river at the point of exposure of the marble and the gentle dip of the marble in a southeasterly direction, the deposit also shows on the left

(southeast) side of the river in the same section, but to a much less extent.

These deposits are approximately 6 miles up the Cahaba River from Centerville, and about 7½ miles directly south from Blocton, also about ½ mile distant from the Blocton-Centerville pike. The Eoline branch of the Mobile & Ohio Railroad could be reached by a spur track in less than 5 miles.

The belt of marbleized limestone leaves the river in the SW. of the SW. of S. 32, and continues as a narrowing belt into the southwest portion of S. 31 adjoining, where it practically dies out. In the east-northeast direction the marbleized rock seems to be somewhat thicker, as far as exposed, but is mostly concealed for some distance after leaving the river, except in the NE. of the NE. of S. 32—where a small branch exposes a portion of it.

CHARACTER OF MARBLE.

The marble exposed in the bluffs along the river has in general a light gray tone. In some layers there are a great many white calcite streaks and in much of the marble there are spots and small irregular areas of yellowish color. A portion of the marble, at least locally, shows a considerable amount of variegation due to coloring of the otherwise light gray marble by veins, streaks, and irregular masses of deep red.

Mr. McCalley* refers to the red-stained layers of variegated marble in the quarry as probably representing the same horizon as the iron-ore beds which occur on the old McIlwain property about 1½ miles southwest of the quarry. It is known that this ore is local in its occurrence, in some places lying between Pelham and marbleized Beekmantown limestone, and in other places between Pelham and a dolomite of either Knox or Beekmantown age.

From a rather hasty study of the marble deposits at the location of the old quarry by the river, I am led to the conclusion that the variegated marble, showing the admixture of deep red angular masses of marble with the light gray, is due to faulting, and that this extremely variegated deposit is a fault breccia.

*Valley Regions of Alabama, Part II, p. 499.

A study of the marble by means of thin sections under the microscope, shows it to be of semi-crystalline character, as can be seen in Plate VII A.

The marble takes a beautiful polish and has been in the past used for interior decoration, as well as for monumental purposes. The court house at Marion, Ala., is one of the buildings using material from this quarry.

AGE OF MARBLE.

The main mass of the marble is of Pelham age, chiefly lower Pelham or Chazian, but locally the Beekmantown limestone underlying the Pelham unconformably and varying greatly in thickness, is also marbleized. This is especially the case near the center of S. 31, which adjoins the section showing the marble bluffs.

CONDITIONS TOWARD THE NORTHEAST.

There are few good exposures of the Pratt's Ferry marbleized horizon farther to the northeast and east of this area for some distance, but it appears that the Beekmantown thickens in this direction, and that, while it is gray in color, closely resembling the Pratt's Ferry marble, yet it is less crystalline and could not be considered a marble. In this direction also the lower portion of the Pelham seems to be seldom if ever sufficiently recrystallized to be properly called a marble.

MARBLE OUTSIDE THE MAIN DEPOSIT.

Besides the marble in the Pelham and Beekmantown, there are two beds of light gray semi-crystalline marble, varying somewhat in thickness, but averaging not over 20 feet, which occur in the dolomite area in belts parallel with the main deposit, but some distance back from it. At one time marble was both quarried and sawed from the lower of these two beds. This lower bed of marble is well exposed a little north of the center of S. 28, T. 24-N., R. 10-E., on the Cahaba River; a little east of the center of S. 36, T. 24-N., R. 9-E., and at Avery's bluff on the Cahaba River in the eastern portion of S. 14, T. 23-N., R. 9-E. The upper layer is exposed at the ford of Schultz Creek, in the SW. of S. 1, T. 23-N., R. 9-E. and again on Burkhalter Branch, in the NW. of the NW. of S.

32, T. 24-N., R. 10-E. The line of approximate outcrop of these two marble beds is to be seen on the sketch map, Figure 26.

STRUCTURE.

The main deposit of marble which is exposed in the bluffs above referred to along the Cahaba River in S. 32, represents the outcrop of the western limb of a syncline or trough, which dips under the river to the southeast. The east limb of this syncline again rises to the surface, or nearly to the surface, in the distance of about a mile across the strike to the southeast before again dipping, or being cut off by a fault, (see Structure Section, Figure 27).

The chief marble deposits of the Pratt's Ferry district, therefore, occur in a limtied portion of the western outcropping limb of a basin-like area which has practically no outcrop on the eastern side of the basin.

THICKNESS MAIN DEPOSIT.

In the neighborhood of the old quarry and mill, which were located on the variegated marble deposit in the NE. of the NW. of S. 32, T. 24-N., R. 10-E., the thickness of the stone which has been sufficiently metamorphosed to be classed as a marble, is not far from 225 feet.

The marble thins to the southwest of the old quarry and becomes of poor grade towards the northeast, yet the quantity of available marble is very great.

SHELBY COUNTY VARIEGATED MARBLES NEAR CALERA

LOCATION AND AGE.

About four miles a little to the south of east of Calera, in Shelby county, occurs a deposit of variegated marble belonging in age to the Beaver or Aldrich limestone, which occurs toward the base of Montevallo shale formation. All the strata in this area are somewhat metamorphosed.*

The marble deposit is exposed in two contiguous valleys. The best exposed locality is about ¼ mile southwest of the point where the main stream of the Buxahatchee Creek cuts

*Report on the Valley Regions of Alabama, Pt. 2, Geol. Surv. of Alabama, 1897, pp. 513, 514.

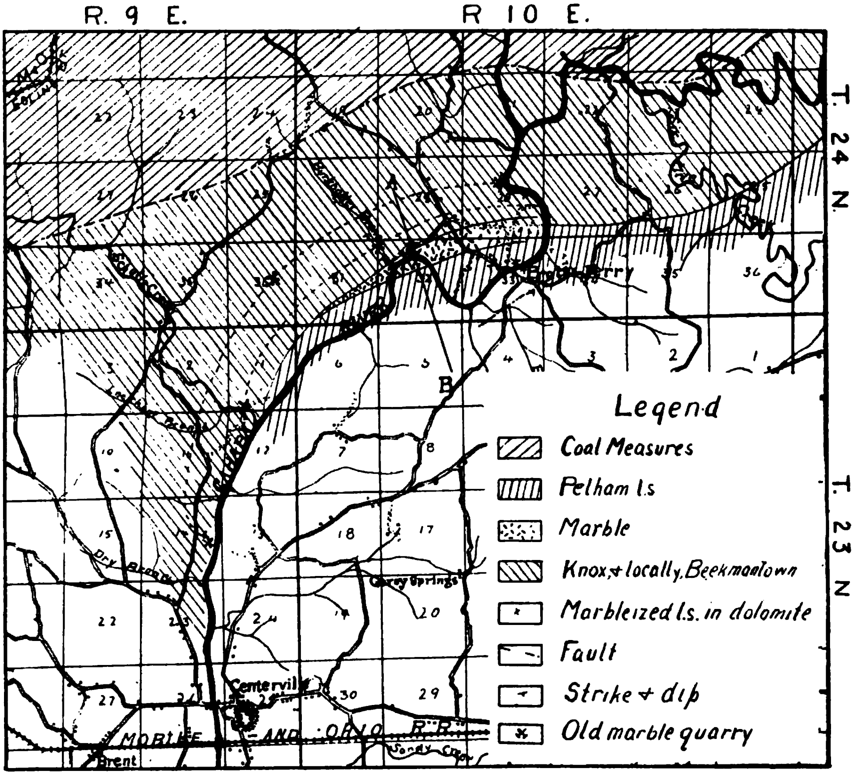

FIGURE 26. Map of the Pratt's Ferry marble deposits showing geological setting. See Figure 27 for structure of the measures along the line A-B.

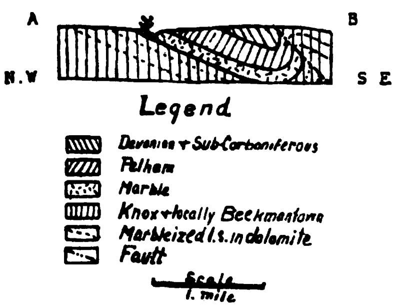

FIGURE 27. Section across the strike through the Pratt's Ferry marble deposit, showing the basin-like character of the deposit and explaining the absence of outcrop of the marble on the east side of the basin and the sub-carboniferous isolated area on the highland east of the river. The depression in the marble outcrop represents the location of the Cahaba River. The old marble quarry was located on the west bank of the river at this point in the NW. of S. 32 (see map Figure 26).

through, and parallels for a short distance, the outcrop of marble. It is here in a steep bank at the head of a ravine in the NW. ¼ of the NE. ¼ of S. 8, T. 24-N., R. 14-E. The other exposure is about 1¼ mile northeast of the one just mentioned near a small branch of the Buxahatchee on the property of J. W. Miller, in the NE. ¼ of the NW. ¼ of S. 4, T. 24-N., R. 14-E. Between these two localities the marble is not exposed though its location is marked by a ridge-forming sandstone which occurs immediately under the marble.

ACCESSIBILITY.

The southwestern of the two exposures is easily accessible to the Louisville and Nashville Railroad, which could reach it by spur track, having low grade, in a distance of less than two miles. (See map of area, Figure 28.)

CHARACTER OF MARBLE.

Mr. Butts* gives the following section at the southwest of the two exposures:

Sandstone, highly ferruginous (loose ore)	20′
Shale, weathering yellowish-green	20′
Marble, thick-bedded, fine grained, variegated	25′
Sandstone (quartzitic?) coarse, with quartz veins	50′

The character of the marble is also described by Mr. Butts as follows:

"The marble is thick bedded, the layers being 3 to 4 feet thick. They are cut by joints which divide them into blocks of considerable size, and it seems probable that under good cover even larger blocks would exist. The dimensions of slabs or blocks that could be obtained would have to be determined by tests involving excavation and the actual working of representative samples of the rock. The rock is very fine grained and takes a high polish. Part of the layers are gray and part are variegated with deep red and pale pink, the whole stratum being composed perhaps of one-half of each kind. The color is due to a coating of iron oxide on the limestone grains. The variegated layers appear to prevail in the upper portion, the gray layers below. The rock is traversed by

*Contribution to Economic Geol. Bull. 470, pp. 287-289, 1910.

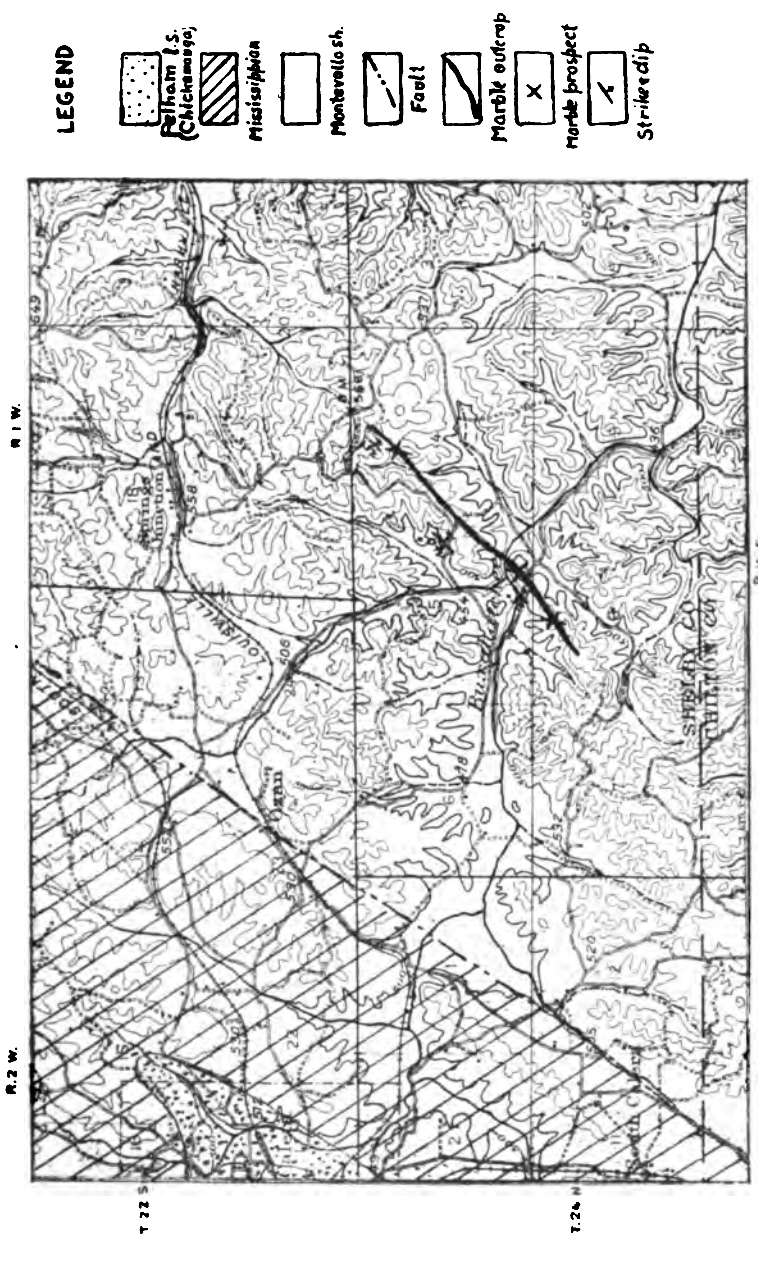

FIGURE 28. Showing location and geological setting of the Shelby county variegated marble.*

*Geology from map by Chas. Butts, Bull. U. S. G. S., 470.

many white and bluish-gray calcite veins, and here and there by thin stringers of small quartz grains. The variegation gives to the rock a highly ornamental effect when polished, and it would appear to possess superior qualities for decorative purposes."

On the property of J. W. Miller in NE. of NW. S. 4, T. 24, R. 14-E., the exposure shows the upper portion of the marble bed for about 15 feet. There seems to be 10 to 15 feet more marble concealed in the valley. The marble here is similar to that shown in the exposure near Buxahatchee Creek.

The marble in the two exposures cited above is semi-crystalline. The particles making the ground-mass are fine, having a grain size of from .03 m.m. to .003 m.m. The crystals which occur in the ground-mass are very irregular in outline and from .1 to .15 m.m. in diameter (see Plate IV A and Figure 29). On account of the perfect cementation of the marble after fracture and on account of the interlocking character of the crystals, the marble should be unusually strong.

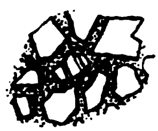

FIGURE 29. An enlarged sketch of portion of Plate IV A, showing the angular character of the grains and the fine ground mass between the grains. Variegated marble from near Calera, Shelby county. Enlarged 120 diameters.

ONYX MARBLE

LOCATION AND EXTENT OF DEPOSIT.

A cave of considerable dimension occurs in the Knox Dolomite formation about 5 miles a little N. of E. of Childersburg in the SE. of the NE. of S. 12, T. 20, R. 3-E. In the huge entrance chamber of this cave, which is approximately 125 feet wide and 450 feet long, there is a large amount of high grade onyx-marble. The stalactites hang in large masses from the high ceiling, and the drippings from the stalactites have built up numerous massive stalagmites, some of the larger ones being as much as 10 feet in diameter. In other places the stalagmites and stalactites have grown together forming massive columns of onyx-marble. Locally the precipitation of the onyx-marble on the side walls of the cave have considerable thickness, while

in other places, as is to be expected, the onyx coating is very thin. There are a number of rooms and passage-ways leading from the main entrance chamber, which have available onyx-marble. Prospecting near the entrance of the cave has shown the presence of large onyx boulders. One of these seen had a maximum diameter of 12 feet. These boulders occur in the dolomite and red clay soil, and evidently mark the position of passage-ways into the cave which have been filled by the precipitation of the calcium carbonate from the mineral waters seeking entrance into the cavern.

The natural entrance into the cave has been enlarged by an open cut 230 feet long, 27 feet deep, and 15 feet wide at the bottom. This cut is nearly on a level with the floor of the cave. In this cut, which shows about two-thirds red clay and gravel, and one-third stone, onyx was encountered in the form of boulders in the dolomite within about 20 feet of the main entrance to the cave. It is figured that this latter part of the cut will yield about 1½ car loads of high grade onyx.

Up to the present time no work has been done in the cave toward developing the marble.

QUANTITY.

Several mining engineers from the different railroads, have visited the cave in the last 2 or 3 years. These engineers have reported from 100,000 to 200,000 cubic feet of onyx-marble in sight. They also seem convinced that there is a considerable amount of boulder onyx in the mountain in the neighborhood of the cave.

CHARACTER OF MARBLE.

A large percentage of the stone occurring in the stalactites and stalagmites is available for use. The color on an average is excellent, and the onyx is much freer from holes than many of the cave onyx deposits. The coloring in the marble is for the most part cream, pink, and red, and the stone is full of life and transparency. An analysis of this marble made by the Tennessee Coal, Iron & Railroad Co., shows 99 per cent. calcium carbonate, and about 1 per cent. silica and iron.

ECONOMIC CONSIDERATION.

The cave is located within about 2 miles of the Southern Railroad, and a spur track could be extended to the opening of the cave without much grading.

At the present time the European war has disturbed the market for onyx, but ordinarily the price of onyx-marble of an average grade is about $6.00 per cubic foot, f. o. b. The demand for onyx-marble is relatively small, but it is thought by men in the marble business that market could be had for at least 10,000 cubic feet per year, and possibly a greater amount if the market was carefully solicited.

There are doubtless many other caves in the great limestone region of the State which have considerable amount of onyx-marble. There are, however, many things to be considered in the development of such a property, and the quantity of onyx in such caves is usually very much overestimated by those who have not had experience in such matters. Before developing cave properties it would be wise to have them carefully examined by a competent geologist or mining engineer.

MINOR MARBLE DEPOSITS

VARIEGATED MARBLES.

Besides the variegated marble from near Calera, which is described elsewhere in this bulletin and which is of Cambrian age, there are a number of localities, especially in Jefferson and St. Clair counties, where rocks of Pelham age yield variegated marbles. In nearly every case these deposits are near the base of the Pelham formation and usually are near a fault or represent a brecciated deposit.

NEAR McCALLA STATION, JEFFERSON COUNTY

One of the best known of these deposits* occurs about a mile west of McCalla station in the SE. ¼ of NW. ¼ of S. 35, T. 19, R. 5-W. Another locality† is just east of Bessemer in NW. ¼ of S. 11, T. 19, R. 4-W. In both these localities the marble is highly ferruginous and locally tinged greenish.

NEAR GREENSPORT, SHELBY COUNTY

According to M. Tuomey,‡ "A very elegant marble occurs above Ashville. It is gray with bright yellow and greenish veins. It occurs in thin beds in a ridge cut in two by Canoe

*McCalley, The Valley Regions of Alabama, Pt. II, p. 337.
†McCalley, The Valley Regions of Alabama, Pt. II, p. 340.

Creek, not far from where the road to Greensport diverges from the Ashville road."

TERTIARY MARBLE

In the St. Stephens or Vicksburg limestone of the Tertiary formation, at Gainestown, St. Stephens and other localities, there are numerous occurrences of hard fossiliferous limestone which takes a good polish, and from its pleasing colors, red, yellow, gray, etc., should be good for decorative purposes. None of this marble has as yet been utilized, nor have any of the occurrences been investigated as to their commercial possibilities.

BLACK MARBLE.

There are several places in the State where black marble is known to occur, although it has never been worked commercially, for the reason that there is very little market for this stone at the present time. Most of the so-called "black marble" is not a marble at all but is a very dark gray limestone which takes a nearly black polish. (For the character of the grain of this marble see Plate V B.)

COLVIN MOUNTAIN, CALHOUN COUNTY

On the north side of Colvin Mountain, near its eastern extremity, about eight miles west of Piedmont and about ¾ mile a little east of south from the point where Calhoun, Etowah and Cherokee counties corner, there is to be found a small opening in a deposit of "black marble" of probable Pelham age. The deposit as shown here is for the most part thin bedded, the layers being seldom more than two feet in thickness. At other exposures in this same region, however, the layers are much thicker. A shaft of black marble from this locality is on exhibition in the Alabama Museum of Natural History at the University of Alabama. Between the above exposure on the north foot of Colvin Mountain and the Coosa River, along the foot of Colvin Mountain and in the bottomlands bordering it, there are to be found a number of exposures of this black marble.

‡Second Biennial Report on the Geology of Alabama, 1858, p. 121.

NEAR WEAVERS, CALHOUN COUNTY

Between Anniston and Jacksonville and about two miles northeast of Weavers, near the pike, is an exposure of black marble practically identical in its nature to that already mentioned as coming from west of Piedmont. In both the above-mentioned localities white calcite veins and streaks occur in the marble, adding greatly to its beauty.

PRATT'S FERRY, BIBB COUNTY

Black marble of Pelham age is reported from just southeast of Pratt's Ferry,* Bibb county, in S. 33, T. 24, R. 10-E.

SHELBY COUNTY

The variegated Cambrian marble from near Calera is said to change locally to a black marble.

GRAY MARBLE

TENNESSEE VALLEY.

A semi-crystalline gray marble occurs in the Sub-Carboniferious limestone in a number of places in the Tennessee Valley. This gray marble resembles the commercial gray marbles of Tennessee. Some very beautiful samples have been recently received by the Geological Survey of Alabama from a little southeast of Decatur, Alabama. A photomicrograph of a thin section of this marble from the NW. corner of S. 13, T. 6, R. 3-W is represented in Plate VII B.

CHEWACLA DOLOMITE MARBLE, CHEWACLA, LEE COUNTY

About 5 miles southeast from Opelika, Lee county, occurs a narrow strip of highly crystalline dolomite (see thin section Plate VI A). This dolomite is for the most part a beautiful pearly white stone. The belt in which the dolomite occurs is about a third of a mile wide and is known to extend for several miles in a northeast and southwest direction (see map of the area, Figure 30). This stone has been quarried extensively in the past for lime. The chief quarry is located near Chewacla in the NE. of the SE. of S. 4, T. 18, R. 27-E. Quarries in this dolomite have been opened at several places in the past, including Echols' Mills and Springvilla.

*Henry McCalley, Report on the Valley Regions of Alabama, Pt. II, p. 499.

Chemical analysis shows the stone to be a nearly pure dolomite.

A light colored talc occurs in some of the layers in small streaks and spots and where present in considerable amount would interfere with the use of the stone for ornamental purposes. It is probable that there are portions of the deposit free from the talc impurity, and if prospecting proves this to be the case we would have here a first-class building stone.

The Chewacla dolomitic marble is almost identical in appearance with the Cockeysville dolomitic marble of Maryland, so much used in and about Baltimore.

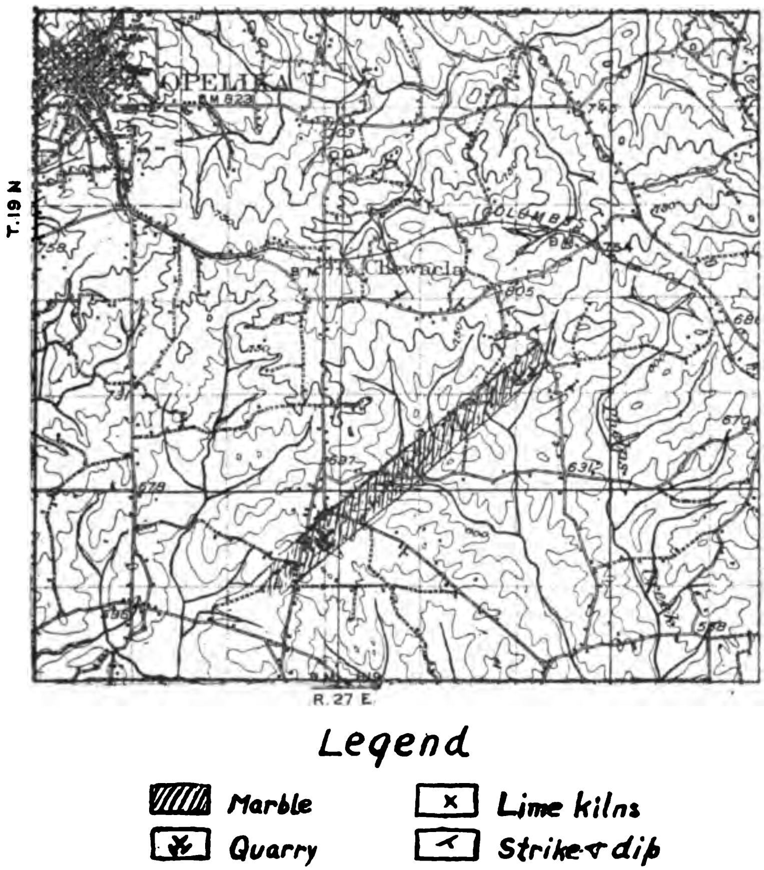

Figure 30. Showing the location of a part of the Chewacla dolomite marble deposits.

CHEMICAL PROPERTIES OF ALABAMA MARBLES

*Analyses of Three Alabama Marbles.**

SiO_2	6.66%	2.49%	3.24%
Al_2O_3	1.38	.61	.35
Fe_2O_3	.51	.23	.29
FeO	.63	undet.	undet.
CaO	32.14	53.55	37.20
MgO	15.31	.53	14.42
Na_2O	.03	.03	trace
K_2O	.54	.29	.03
H_2O at 105	.12	.04	.06
H_2O above 105	.72	.12	.18
TiO_2	.12	.02	....
CO_2	41.80	42.49	44.61
P_2O_5	.10	undet.	undet.
MnO	.10	trace	.004
SO_3	.01	undet.	undet.
	100.17	100.40	100.384

(3) Pink marble from about four miles south of east of Calera, Shelby county, in SE. of SE. of S. 5, T. 24 N., R. 14 E.
(6) Bluish gray marble, from McKenzie quarry near Taylor's Mill in NW. of S. 7, T. 19, R. 6 E.
(24) Bluish-white, compact marble from Nix quarry.

R. S. Hodges, Analyst.

*Analyses of a number of Alabama Marbles.**

	1	2	4	11	15	19	33	34	35	37 & 38
Silica (SiO_2)	2.42	1.01	.29	3.16	.51	.46	1.03	.38	1.32	.16
Alumina ((Al_2O_3)	1.81	.37	.08	.31	.07	.21	.16	.13	.69	.07
Iron Oxide (Fe_2O_3)	.74	.60	.04	.16	.06	.25	.07	.06	.21	.02
Lime (CaO)	48.35	30.54	55.69	49.75	54.76	54.00	55.10	55.47	52.24	55.70
Magnesia (MgO)	3.61	20.31	.28	3.53	.32	1.34	.30	.35	2.08	.21
Sulphur	....	....	....	....	....	....	....	....	....	....
Carbon dioxide (CO_2)	42.71	47.39	43.60	42.77	43.44	43.94	43.23	43.71	43.11	43.74
Total	99.64	100.22	99.98	99.68	99.16	100.20	99.89	100.10	99.65	99.90

	A	B	C	D	E	F	G	H	I	J	K
Silica (SiO_2)	1.32	1.35	3.00	3.28	3.72	1.30	.28	1.35	2.80	2.80	.33
Alumina (Al_2O_3)	.23	.23	.23	.26	.29	.70	.28	.30	.48	1.16	trace
Iron Oxide (Fe_2O_3)	.23	.23	.23	.26	.29	.70	.28	.30	.48	1.16	.05
Lime (CaO)	54.84	55.13	53.97	53.96	53.70	44.11	55.58	54.70	53.58	52.10	55.13
Magnesia (MgO)	.91	.33	.45	.52	.47	9.08	.08	trace	.31	1.59	.36
Sulphur	....	....	....	....	....	....	....	....	....	....	.013
Carbon dioxide (CO_2)	44.03	43.60	42.84	42.91	42.73	44.51	43.67	42.90	42.37	42.59	43.32
Total	101.33	100.64	100.49	100.93	100.91	99.70	99.89	99.25	99.54	99.19	99.203

*Analyses 1-38 also A-E made by R. S. Hodges of the Geological Survey of Alabama.
Analyses F-J taken from Report on the Valley Regions of Alabama, Pt. II, p. 671.
Analysis K, Ricketts & Banks.

Description and Localities of Marble in Foregoing Table.

1. Average of two samples of variegated marble, Shelby county, from about 4 miles a little south of east from Calera, exposed on Buxahatchee Creek in the SE. of SE. of S. 5, T. 24-N., R. 14-E.

2. White, coarsely crystalline dolomite from L. & N. Railroad crossing of Tallaseehatchee Creek in SW. of S. 11, T. 21-S, R. 4-E.

4. Cream white crystalline marble, Gantt's Quarry.

11. Marble from Van Deusen Spring near Sylacauga in SW. of NE. of S. 28, T. 21-S., R. 4-E.

15. Light blue marble from Tallaseehatchee Creek from SW. of SE. of S. 11, 2. 21-S., R. 4-E.

19. Black marble from deposit about 7 miles a little north of west of Piedmont, Calhoun county, in the SW. of S. 30, T. 12-S., R. 9-E.

33. Bluish marble, Darden place, from about the center of the SW. of NW. of S. 13, T. 24-N., R. 16-E., about 1½ miles a little east of north from Marble Valley P. O., Coosa county.

34. Sugary-white somewhat weathered marble from H. Hamilton's place close to "sink," near north line of SE. of NW. of S. 7, T. 22-S., R. 3-E.

35. White and blue clouded marble from west side Hamilton place by branch in SE. of NW. of S. 7, T. 22-S., R. 3-E.

37. Light pink toned marble from Pratt's Ferry, Bibb county.

38. Grayish toned marble from Pratt's Ferry, Bibb county.

A. White marble, Hickman Quarry.

B. White marble, Leak Quarry.

C. White marble, McKenzie White Quarry.

D. Light blue marble, McKenzie Quarry.

E. Dark blue marble, McKenzie Quarry.

F. Bowie Quarry, NE. ¼ of S. 18, T. 20-S., R. 5-E.

G. Gantt's Quarry, E. ½ of NE. ¼ S. 2, T. 22-S., R. 3-E.

H. Nix Marble Quarry, NW. ¼ S. 36, T. 20, R. 4-E.

I. Marble from near Taylor's Mill, SE. ¼ of S. 12, T. 19, R. 5-E.

J. Hickman Marble Quarry, NE. ¼ of S. 22, T. 21, R. 3-E.

K. Marble City Quarry Co., NW. of SE. S. 36, T. 21-S., R. 3-E. Average of analyses from upper, middle and lower beds.

CHEMICAL RELATIONS OF ALABAMA MARBLES.

The twenty-one analyses of Alabama marbles given above are approximately representative of the chemical characteristics of the marble for the areas from which they are respectively taken. In these analyses there is but one dolomite. The percentage of magnesia in the calcite marbles varies from a mere trace, to 9 per cent. in some of the less pure marbles. In the purer crystalline marbles from the central and southern portion of the main marble belt the magnesian content is very small, usually less than 3 per cent. In such cases a study of the marble under the microscope fails to reveal the presence

of dolomite so that it is concluded that the presence of the magnesium shown in the analyses is due to the presence of this element in the talc and chlorite, which minerals are known to be present. In cases where the magnesia content is 3-9 per cent. a study of the crystalline marble under the microscope reveals dolomite crystals. These usually are arranged in thin irregular sheets or small cloud-like masses rather than scattered in a uniform way through the marble. In the semi-crystalline marbles, on the other hand, the magnesia content is apparently distributed widely throughout the rock and in the finer portion or the portion which is less crystallized.

The crystalline marble is lower in silica content as a rule than the semi-crystalline. This may be due in part to the greater segregation of the silica in the crystalline marbles and the rejection of the pure silica or marble high in silica in the samples for analysis, as these would not be suitable for marble. The general conclusion concerning silica in the crystalline belt is that the area toward the northeast is higher in silica than is the marble from the central and southern yet the silica is so evenly distributed in the higher silica marble as to be of small consequence in their finishing, except making the marble slightly harder.

The better grade of the Alabama crystalline marbles is as low in impurity and as high in calcium carbonate content as the best foreign marbles and better than many of the most used marbles from other portions of the United States. Most of the Alabama marble now being put on the market is represented by sample No. 4, which shows a calcium carbonate content of approximately 99.3 per cent.

PHYSICAL PROPERTIES OF ALABAMA MARBLES

TESTS OF THE PHYSICAL PROPERTIES OF ALABAMA CRYSTALLINE MARBLE.

*Tests of Marble from Alabama Marble Company's Quarry, Gantt's Quarry, Alabama.**

Marked	Sizes in Inches	Area in Square Inches	Breaking Load in Pounds	Breaking Load in Pounds per Square Inch
Test 1	........3.03x3.02	9.15	125,250	13,690
Test 2	........3.03x2.91	8.82	147,070	16,670

NOTE: Specimen for test 1 was 3.04 high.
Specimen for test 2 was 3.00 high.
Specimen for test 1 was tested parallel to bed.
Specimen for test 2 was tested vertical to bed.

*Riehle Bros. Testing Machine Co., Philadelphia, Pa. (Signed) W. C. DuComb, Jr., Superintendent of Tests.

TESTS ON TWO SAMPLES OF ALABAMA MARBLES*

Comparative Compressive Strength of Dry and Wet Samples.

Lab. No.	Cube No.	Compressive Strength (lb./sq. inch)				Percentage†	
		Dry Stone	Average	WetStone	Average	Loss	Gain
2633	1	14744	14744	15700			
	2			12289	13994	5.08	....
	3	11456	11456	12252	12252	......	6.95
4947	1	18232					
	2	17342	17787	16899	16899	4.99	....
	3	11902					
	4	11129	11515	11482	11482	0.29	....

†Comparative strength of wet and dry stone.
*Selected by Mr. Oliver Bowles of the Department of Commerce, Bureau of Standards, Washington, D. C.

Remarks: Sample 2633 was from Gantt's Quarry being nearly clear white, almost free from bedding marks, but showed a few strain lines.
Sample 4947 was from Sycamore, having a few greenish markings and also an occasional strain line.

Comparative Compressive Strength of Original and Frozen Samples and Change in Weight on Freezing.

Lab. No.	Cube No.	Compres. Strength (lb./sq. in.) Orig'l Sample	Averg.	Frozen Sample	Averg.	Percentage* Loss	Percentage* Gain	Percent.† Loss
2633	1	14744	14744	17668	17668	....	19.85	0.08
	3	11456	11456	16489	16489	....	43.90	0.38
4947	1	18232		16773				0.04
	2	17342	17787	16930	16851	5.27	....	0.04
	3	11902		13362				0.05
	4	11129	11515	....	13362	....	15.15	

*Comparative strength of original and frozen samples.
†Percentage of change in weight.

Remarks: Sample No. 1 and 2 were tested on bed and No. 3 and 4 were tested on face.

Percentage of Absorption, True Specific Gravity, the Apparent Specific Gravity and Porosity.

Laboratory Number	Cube Number	Percentage of Absorption	Average	Apparent Specific Gravity	Average	True Specific Gravity	Average	Percentage Porosity
2633	1	0.073		2.718		2.735		
	2	0.085	0.079	2.717	2.718	2.734	2.732	0.513
	3	0.078		2.719		2.728		
4947	1	0.054		2.721		2.738		
	2	0.062	0.059	2.720	2.721	2.732	2.733	0.439
	3	0.060		2.721		2.728		

Transverse Tests.

Lab. No.	Cube No.	Manner of Testing	Modulus of Rupture	Average
2633	1	⊥ to bed	2764	
	2	⊥ to bed	2124*	2170
	3	⊥ to bed	1623†	
4947	1	⊥ to bed	3507	
	2	⊥ to bed	3377	3442
	3	‖ to bed	1724	
	4	‖ to bed	1755	1740

*Broke in strain line 1½ inch from center.
†Broke in strain line 1½ inch from center.

Remarks: ⊥ indicates that the breaking load was applied perpendicular to the direction of bedding and || that it was applied parallel to the direction of the bedding.

(Signed) S. W. Stratton, Director.

Bureau of Standards,
Washington, D. C.
September 1, 1915.

Concerning the above tests made by the Bureau of Standards, the Director of the Bureau makes the following explanations:

All compression tests were made on 2¼" cubes, crushed in the 200,000-pound Olsen screw gear machine. The cubes were ground smooth on a fine carborundum grinder and the two opposite faces to bear the load were made as nearly parallel as possible. All cubes were tested between cardboards with a 6½" spherical block below.

The freezing tests consisted in determining the change of weight and strength of 2¼" cubes after 30 freezings. The cubes were first dried in the electric oven at 110° and weighed. After 30 alternate freezings they were again dried and weighed, the change of weight being expressed in percentage of the original weight. The cubes were crushed and the resulting strength compared with that obtained from unfrozen cubes.

Absorption tests were made on three cubes of each sample dried at 110° until no further loss of weight occurred. These cubes were placed in a shallow basin of water until no further increase of weight could be detected. They were carefully dried with a towel and weighed. The percentage of absorption was obtained by dividing the increase in weight times one hundred by the original weight of the dried stone.

The apparent specific gravity was obtained from the cubes used in the absorption test, by determining the loss of weight of the wet blocks suspended in water and dividing the weight of the dry cubes by this loss. The true specific gravity was obtained on the powdered material which passed a 200-mesh sieve. The dried powder was wieghed out in 60-gram samples and the volumes determined in the Le Chatelier flask. The porosity was obtained by multiplying the difference be-

tween the true and apparent specific gravity of the sample by 100 and dividing by the true specific gravity.

The transverse tests were made on pieces approximately 1½" x 3" x 12". These pieces were supported on knife edges 10 inches on centers in the 20,000-pound Olsen machine and the load applied through a third knife edge at the center of the span.

We regret that some of the compression tests were confined to so small a number of cubes which was due to the fact that some of the cubes were found unfit for test due to the presence of strain lines. However, we still have a portion of the samples and we hope to supplement these results with more complete tests when other cubes can be prepared.

A peculiar feature of these tests is that fact that the frozen cubes gave higher compressive strengths, in all cases except one, than the unfrozen. This peculiarity has been found occasionally in tests of other stone at this laboratory and at present we are not able to offer any definite explanation for it."

NOTES ON THE PHYSICAL CHARACTERISTICS OF ALABAMA CRYSTALLINE MARBLE.

The most important physical characteristic of a marble is its color, for upon this chiefly depends its market value. The colors demanded by architects differ slightly from time to time, but as a rule the same general color effects are always thought desirable or undesirable. The light colored marbles are the most desirable and of the modifying colors those which give "warmth" to the marble are the most sought after. Next to color the most important physical characteristic of a marble is its texture or grain, whether coarse, medium or fine. As marble is primarily an ornamental stone, its attractiveness is its prime requisite, thus the importance of color and texture. There are other physical characteristics, however, which it is essential to consider in the choosing of a marble for each particular purpose.

CHARACTER OF CRYSTALLIZATION

There are several varieties of marble in Alabama, some have been wholly recrystallized by great heat and pressure and show

a high percentage of the calcite crystals with twinning bands. (See Plate I, Gantt's Quarry marble.) Twinning is induced by the movements of the marble and is a partial index of the amount of disturbance and the time of disturbance. Twinning is not a sign of weakness, although it indicates movement in the marble, for tests on the twinned marbles are fully as satisfactory as upon those which are but slightly twinned. Other marbles in the State are but partially crystallized, sometimes classed as "semi-crystalline" marbles. These show a wide range in the percentage of crystallized grains. A blue layer in the marble from Tallaseehatchee Creek shows a small percentage of the marble still very fine grained (see Plate V A). The variegated marble from near Calera is also largely crystalline but the larger crystals are very fine compared to those in the marble from the crystalline belt (Plate IV A shows a photomicrograph, enlarged 50 diameters, and Figure 28 shows a sketch of the same enlarged 120 diameters). Most of the so-called "black marble" from Calhoun county and the northeastern part of the State is but slightly crystallized (see Plate V B), and in fact from its texture belongs to the limestones rather than the marbles.

GRAIN SIZE

As would naturally be expected, there is a very great difference in the size of the crystals in the holo-crystalline marbles in general. There is in the so-called crystalline marble belt of Alabama a corresponding difference of grain size depending upon the age of the formation from which the marble comes or upon the location in regard to the intensity of metamorphism. The dolomitic marble from near the Louisville and Nashville Railroad bridge over the Tallaseehatchee Creek (Plate VI B) shows average maximum grain size of 3.3 m.m., while the light blue marble from the McKenzie Quarry shows (Plate III A) a maximum average grain size of .25 m.m.

The Alabama crystalline marbles are slightly finer in grain than the Vermont, belonging largely in size groups 2 and 3 (see table of grain sizes below), while the Vermont is classed largely in size groups 3 to 5, and the Georgia marble in size groups 5 to 7.

Table Showing the Grain Size of Different Alabama Marbles in Comparison With a Few Other Well Known Marbles of This Country and Abroad.

Name of Marble and Location	Grade* (size of grain)
Alabama Crystalline Marbles in General Marble Belt:	
White marble, Alabama Marble Co., Gantt's Quarry, NE. S. 2, T. 22, R. 3-E.	3–
White marble, Nix quarry, SW. S. 36, T. 20, R. 4-E.	2–3
Blue marble, Nix quarry, SW. S. 36, T. 20, R. 4-E.	1
White marble, Alabama Marble Quarries Co., NE. S 1, T. 21, R. 4-E.	2–3
Herd quarry, NE. S. 22, T. 21, R. 4-E.	2–3
Light blue marble, McKenzie quarry, N. ½ S. 7, T. 19, R. 5-E.	1
White marble, Eureka White Marble Co., SW. S. 12, T. 24-N, R. 16-E.	2
White marble, Moretti-Harrah Marble Co., NE. of SW. S. 36, T. 21, R. 3-E.	3+
Clouded white marble, VanDeusen Spring, SW. of NE. S. 28, T. 21, R. 4-E.	2
Light blue marble, Tallaseehatchee Creek, SW. of SE. S. 11, T. 21, R. 4-E.	2
Other Alabama Marbles:	
Variegated marble, southeast of Calera, NE. of S. 8, T. 24, R. 14-E.	1–
Variegated marble, Pratt's Ferry,NW. S. 32, T. 24, R. 10-E.	1+
White dolomitic marble, Chewacla dolomite, E. ½ S. 4, T. 18-N., R. 27-E.	5½
White dolomitic marble, by L. & N. R. R. crossing Tallaseehatchee Creek in SW. S. 11, T. 21, R. 4-E.	7+
†*Vermont Marbles:*	
"Statuary Rutland" Goodell quarry, Brandon	2
"Second Statuary Rutland" Eastman quarry	3
"Dorset A." Dorset Mountain	5
Georgia Marble:	
"Creole," Georgia Marble Co.'s quarry, Pickens Co.	6
Etowah quarry, Pickens Co.	5+
Marble Bluff quarry, Gilmore Co.	4–
†*Grecian Marble:*	
Parian Statuary	6
Pentelicon commercial	3
†*Grecian Marble:*	
Carrara ordinary	4

*Grade number is according to classification of grain size used by T. N. Dale in Bull. U. S. G. S. 521, p.

†According to T. N. Dale, Bull. U. S. G. S. 521.

GRAIN CHARACTER

The shape of the crystal varies also as markedly as the size. They may be regular in outline or they may be very irregular and have an interlocking character. The toughness and the ease of crushing or sawing depend in no small degree upon this character of grain shape. The Alabama marbles are as a rule markedly irregular in grain and show distinct interlocking character. (See Figure 25.) This character is as a rule much more marked than in either the Vermont or the Italian marbles, and explains why the Alabama marbles are more difficult to saw and why they are comparatively more resistant to breakage in handling.

For the most part the Alabama marbles show under the microscope but slight if any schistose character, but samples taken from certain layers, where slickensides ("reeds" of the quarrymen) occur, show marked elongation of the crytals.

This character is especially well marked in certain layers of the marble from the deposits in the neighborhood of Taylor's Mill toward the northeast end of the field, where from the character of the marble it is evident that thrust movements have taken place when the marble deposit was not deeply buried in the ground. (Plate III B shows a photomicrograph of the schistose marble from near Taylor's Mill, and photograph, Plate XXVII B, shows a hand specimen of this schistose marble.

TESTING OF MARBLE*

The more important tests of marble for economic uses are described below.

Chemical analysis.—This should have special reference to the content of iron sulphide or oxide.

Microscopic analysis.—For this purpose a number of thin sections should be made from cubes sawed, not hammered, from blocks taken at different heights in the same bed and horizontally far apart, and some sections should be cut transverse to the bed, others parallel to it.

The microscopic analysis should determine the grain form, the grain regularity, the average grain diameter by the Rosiwal method, the associated minerals and their relative abundance, and the presence of minute beds or lenses of dolomite and of divisional planes of bedding or cleavage.

ABSORPTION

Hirschwald found that after Carrara marble was exposed on all the 23 rainy days of November and December, 1900, its maximum water absorption was 0.45 per cent and that the same marble when tested experimentally in the laboratory showed after one hour's immersion 0.49 per cent of absorption He also found that the water absorption of a coarse Tyrolese marble under slow immersion amounted to 0.74 per cent of the stone, in vacuum 0.82 per cent, and under pressure of 50 to 150 atmospheres 0.92 per cent, and that the water absorption of this stone thus tested amounted to 81.37 per cent of its total pore space, or in vacuum 90.01 per cent.

POROSITY

One of the simplest methods of determining porosity is to expose sawed blocks 2 by 1 by 1 inch for a few hours to a temperature of about 104° F. and then to immerse them for 48 hours in a concentrated 4 per cent alcoholic solution of

*From Bulletin 521, U. S. G. S., pp. 160-162.

nigrosine, a deep-blue dye soluble in alcohol. After drying for half an hour the blocks are to be broken squarely across with hammer and chisel. The degree of porosity will be indicated by the extent to which the dye has penertated the blocks.

COMPRESSIVE STRENGTH

This should be tested on 6-inch sawed cubes with hydraulic compressor, as in the Watertown Arsenal tests. One set of blocks should be tested on the bed and another on edge.

TRANSVERSE STRENGTH

This should be tested on sawed blocks between supports and both on bed and on edge.

TENSIONAL STRENGTH OR COHESION

This should be tested by a method described by Hirschwald. A sawed block of certain shape with lateral grooves in the center is fastened at each end into a steel frame provided with a hook. The tensional weight is applied to one of the hooks and the block is suspended by the other.

MAGNETISM

A marble for use in electric switchboards should contain little or no magnetite. There is probably a slight difference in the amount of this mineral in different marbles, although the quantity in any one is exceedingly small. Its effect on an electric current should therefore be tested.

TRANSLUCENCE

Marbles differ considerably in translucence, which can be tested by sawing very thin pieces of measured thickness and superpcsing them in order to determine the thickness traversed by light.

POLISH

A polished surface should be examined with a magnifier, and the pits or protuberances noted.

DURABILITY OF COLOR

This can be determined by exposing a sand-rubbed and a polished surface to the south for three years and then comparing the surfaces with those of unexposed pieces prepared from the same block at the same time.

SONOROUSNESS

This is an index of cohesion. It can be tested by hammering sawed slabs 2 inches thick, 4 to 6 inches wide, and 1 to 2 feet long.

STATUARY TEST

Renwick makes this recommendation: Marble for statuary purposes should never be selected in bright weather. Veinings and discolorations are more difficult of discovery at this time than at any other. A dull day with a good light is the best time for inspections; if after a shower of rain, so much the better. Provided no rain has fallen, the blocks should be soused with water; veins and stains can then be more readily perceived. If possible, have each block slung and struck with a hammer. If the sound of the blow is dull and heavy, look out for cracks. Should a hard, metallic tone be emitted the marble will be heavy in working; but if a soft, clear ring is heard, the material is sound and will both work and wear well.

ALABAMA MARBLE AS A STATUARY MARBLE

Mr. G. Moretti, the well-known sculptor, who has used the Alabama marble extensively in his art, has the following to say concerning it:

"The color of the white marble of Alabama is brilliant and full of life with a creamy tone that gives a lustrous transparency, making our marble far more beautiful than the Italian. The Alabama marble has a uniformity of texture most satisfactory and pleasing for sculpture.

The location of the marble region and the ease with which the marble can be quarried, together with the vast amount of the deposit will make it possible to sell the second and third grades for building and architecture at a price easily and successfully competing with foreign marbles and we will be able to sell our finest white marble for prices reasonable enough to make it possible for artists to execute their work in the material that gives to them their greatest beauty.

I read in the 'International Studio' remarks about a very beautiful Greek head recently acquired by the Metropolitan Museum. I have examined the head and many Greek works and I feel sure the beauty of the antique marble is not so greatly due to the aging of the marble as is usually supposed. I think the Greek marble was originally of a cream color and that the artists of the time were greatly inspired by the beauty of their material. I have so often met with the objection from many people loving art who say, 'Oh, but the marble is so cold, now if it only was warm and rich looking like the antique.' But the Alabama marble is just that, it is warm and lustrous and its creamy transparency makes it marvelously life-like.

Architects who have been fortunate enough to know the Alabama marble are already demanding it and the marble is destined to be preferred on its own merits."

GENERAL NOTES ON THE MANUFACTURE OF ALABAMA MARBLE, COST KEEPING, ETC.

By MAJOR JNO. S. SEWELL.

SAWING

Because of the peculiar structure of Alabama marble, and the fact that many of the layers are not of very great thickness, by far the greater portion of it has to be sawed practically parallel with the beds. There are white marbles which can be sawed in any direction with equally good results, but this is not true of Alabama marble. Where it is used in heavy pieces, showing "returns," this involves especial consideration and selection of stock, which must always be carefully attended to.

The marble saws with about the same facility as Italian marbles, and experience so far indicates that the best abrasive is sand. While it can be sawed more rapidly with crushed steel or shot, as the marble finds its principal use in interior work, the presence of shot and crushed steel in it is objectionable for reasons well known to every marble manufacturer. For the benefit of the layman, it may be explained that a slab with a little bit of shot or steel adhering to it, going through subsequent processes, is almost sure to be badly scratched at a later stage when it is otherwise almost finished. This necessitates re-finishing and a reduction in thickness, which often disqualifies the slab and causes its rejection.

FINISHING

Nothing very unusual is required in handling Alabama marble except a perfect familiarity with the stone and an instinctive knowledge of how to use it so as to produce a satisfactorily uniform effect, notwithstanding the somewhat erratic distribution of the clouding and veining. In the various finishing processes, cutting and turning are the only ones that present special difficulties, and these difficulties are practically eliminated by the use of carborundum, instead of steel tools. Owing to the greater hardness of the marble, it probably costs somewhat more to cut it, even with carborundum, but the

marble itself has a margin of superiority over most of its competitors which enables it to bring, on the whole, a little higher price, which in general, should be sufficient to offset the increased cost of working.

COST KEEPING

The greatest source of expense in handling Alabama marble is the waste in handling material disqualified by disagreeable color, and by unsoundness. Anyone entering into the production and manufacture of Alabama marble should by all means introduce a detailed and elaborate cost system which would enable the cost of every operation, from the quarry to the finished material, to be determined with a limit of accuracy not greater than five per cent. It is especially important and desirable to devise a record of the cost of sawing and of the yield of marble which will show how much of waste is due to unsoundness and how much of it to color. That due to unsoundness may be expected to diminish within limits which may be determined within a fair degree of accuracy. That which is due to color is a permanent handicap and can never be overcome.

It is highly important to study all of the finishing processes which are subsequent to sawing in order to discover not only wherein they may be greater or less than might be expected from experience with other marbles, but also to devise proper means and methods of overcoming any natural handicap that may be found to exist. Such records of cost and net yields are of the greatest importance during the period of development. The careful study of such records during this period will save the management from many a costly mistake which may otherwise be easily made. They will also throw light at a comparatively early stage of the game on the question of whether the locality selected is a really promising prospect or not; there is little doubt that there are some localities along the belt in which profitable quarries could never be developed. Proper records of costs and yield would enable a condition of this sort to be discovered before the investment was completely made, and thus enable those concerned either to make a new start in a better place, or at least withdraw without a total loss.

THE COMMERCIAL POSSIBILITIES OF THE WHITE MARBLES OF TALLADEGA COUNTY, ALA.

WHITE MARBLE

BY MAJOR JNO. S. SEWELL.

The deposit of white marble, extending with more or less continuity, from the southwest corner of Talladega county to the vicinity of the town of Talladega, is, in general, what is known as a fine-grained white marble. By the word "white" it is not intended to convey the idea that the marble is pure white. The known supply of really pure white marble is very limited and no great amount of it is known to exist anywhere in the world. The term "white marble" ordinarily means a marble in which the main ground mass is white but generally exhibiting more or less veining and clouding, due to the presence of foreign material, i. e., material of a different chemical composition from that of pure marble.

Nearly every white marble deposit contains some layers, or members, which are more or less blue in ground tone. Every such deposit generally contains more or less layers, or members, in which veins or cloudings of foreign material are so numerous and closely distributed through the mass that the veining, or clouding, gives a predominant characteristic to the marble in spite of its white background.

In any one deposit it generally happens that the locality where there is evidence of more than the average amount of uplift, bending, crushing, flowing, etc., the percentage of bluish marble is much less than it is at other places where these dynamic agencies have been less violent.

IMPURITIES

The principal foreign material in the white marbles of Talladega county, Alabama, seems to have had its origin in small amounts of mud and sediment deposited with the original material. In the subsequent processes to which the deposit has been subjected, this foreign matter has been changed into a

sort of schist, which presents the external appearance of talcose and mica schist, with sometimes the suggestion of chlorite. At all points at which the deposit has been uncovered there is evidence of more or less dynamic action, accompanied in every case with a certain amount of internal flowing. Evidences of the latter action are much stronger in some localities than in others and indicates a relative motion of surprising extent between the upper and lower portions of what was originally a single layer of stone; in no case, however, is the evidence of internal flowing wholly absent.

UNSOUNDNESS

Owing to the stresses to which it has been subjected, the marble of Talladega county exhibits a considerable amount of unsoundness, i. e., cracks or joints; this unsoundness is usually quite marked near the surface and renders profitable quarrying impossible in many cases until a considerable depth is reached.

The deposit, wherever it has been uncovered, is also eroded by ground water. As a result of this, large cavities, filled with soft and liquid mud, are likely to be encountered in a more or less unexpected fashion until a considerable depth has been reached.

This deep erosion was no doubt facilitated by the existence of numerous cracks. The cracks themselves generally occur in three systems, two of which apparently were produced by stresses in the deposit, due to whatever produced the flowing, faulting and tilting; the third system of cracks is apparently due to the expansion stresses induced by changes in temperature since the deposit attained what is practically its present position.

The two systems of cracks, due to stresses in the marble deposit, generally make an angle with each other varying from 60 to 90 degrees, and what appears to be the principal system of these cracks makes an angle of about 40 degrees with the dip of the marble. The expansion cracks run straight down the dip.

STRATIFICATION

The evidence of the original stratified nature of the deposit has been much less completely destroyed in Alabama than in

many other places. At intervals there occur beds or layers of the schist above referred to, which may be from one inch to two inches thick. Where they are of considerable thickness they generally contain a considerable admixture of calcium carbonate, i. e., of marble; where they are not so thick the layer becomes a true vein of practically pure schist. The schist is much weaker than the marble.

QUARRY METHODS

As a result of the conditions above described, in order to secure a reasonable percentage of merchantable stock from Alabama marble, it is necessary to quarry both with the beds, which dip at an angle of from 25 to 45 degrees, and also with the principal system of cracks, which traverse the beds of the marble in a diagonal direction. Where the expansion cracks and the other cracks, due to the movement of the deposit, exist together in the same area, it will often happen that no good marble at all is obtained until one set of cracks diminishes in number so that the individual cracks are much farther apart. In general, there is a gradual improvement in soundness as greater depth is attained, but the improvement in this respect is not continuous. Better and worse conditions alternate as the depth is increased; however, it is generally true that an unsound spot at a greater depth is not quite so bad as a similar unsound spot encountered at a lesser depth.

ECONOMIC CONSIDERATIONS

Because of the physical conditions above described, a quarry in Talladega marble must be developed to a considerable depth over a considerable area before it can be considered to be on a permanent basis of operation. This condition is further aggravated by the fact that even after the blocks have been carefully selected, the internal flowing that has taken place everywhere has caused a somewhat erratic distribution of the veins of schist and the clouding through the mass of marble, and even in blocks which apparently are quite clear of heavy color, sawing may reveal a considerable amount of such color in the interior of the block. After selecting the blocks as carefuly as possible for sawing, there is a waste of fully 30 per cent due to this erratic distribution of color which spoils many slabs and

reduces their grade so that they are no longer merchantable. The marble must be sawed in order to determine what portion of it is thus affected by concealed color, so that the expense of handling unmerchantable stock is very considerable before the merchantable stock can finally be separated from the other with any degree of certainty.

Because of the physical conditions obtaining, it is probable that any industry founded upon the marbles of Talladega county must finally develop into a sawing and manufacturing proposition because the amount of waste necessarily involved would make freight bills very heavy if rough blocks were to be shipped elsewhere to be sawed and finished. There are probably some localities along the deposit where a fairly good business could be carried on on a small scale for a limited time by the sale of blocks, but the deposit is so completely covered with overburden that it is very difficult to select such places with any certainty. From the nature of the deposit, it seems unlikely that even such localities could be developed on a permanent basis for the sale of blocks alone, although there are places which would have a limited life in this respect.

When the merchantable stock has been selected and finished, it presents many advantages over marbles with which it is in competition. It is rather fine-grained, hard, and more impervious than other fine-grained white marbles. It takes and holds a better polish and can be more easily kept clean when it has been installed in a building. It is possible to stain any white marble, but the white marble from Talladega county resists staining better than most others. The Talladga marble is also quite durable exposed to weather when it is properly selected; the evidence at hand seems to justify the inference that it is appreciably more durable than any other white marble of equally fine grain and pleasing texture. In fact, it presents every evidence of being at least as durable as any other marble used for exterior work, and probably more durable than most of them.

So far as its structural strength is concerned, Alabama marble possesses at least as much as any other and more than is necessary for any use to which marble is put under modern conditions.

Owing to the peculiar nature of the internal flowing which has apparently taken place in Alabama marble, it possesses a well-defined grain in one direction similar to that of timber.

This introduces difficulties in finishing it when any considerable amount of hand work is required. The difficulties make themselves especially apparent when it becomes necessary to return a moulding across the end of the grain. The introduction of carborundum for working marble has, however, greatly diminished the difference in the cost of working Alabama and that of other marbles with which it is in competition. Given an adequate development, in other words, a business on a sufficiently large scale, and it seems probable that Alabama could be made to compete with other marbles for all purposes. In the beginning it appeared that probably it could never compete with other marbles except for interior work where its peculiar qualities do not result in any appreciable increase in cost as compared with other marbles.

The principal difficulties to be encountered in developing Alabama marble are: First, adequate development of both quarry and plant. Second, the waste due to unsoundness and to concealed color. Third, the necessity of any organization slowly acquiring a familiarity with the stone which will enable it to be used to the best advantage.

Commercially speaking, it is not a poor man's proposition; it is not a bonanza,—at least not in the sense of large and quick returns; it is a "long pull," involving patience, endurance and the expenditure of much time and money.

Properly developed and adequately capitalized, there is every reason to believe that the white marble of Talladega county can be finally made the basis of a permanent and profitable industry which will finally pay an adequate return on all of the capital, time and labor put into it. There seems no reason why it should not some day develop into an industry as large as that existing in the Vermont marble belt at the present time. But it is probable that this will not occur during the life time of those now interested in the Talladega county marble.

ALABAMA MARBLE HAS BEEN USED FOR THE EXTERIOR OF THE FOLLOWING BUILDINGS

United States Postoffice	Mobile, Ala.
Ogden Armour Residence	Chicago, Ill.
Atlantic National Bank Building	Jacksonville, Fla.
First National Bank Building	Alexandria, Va.
Sommerset County Court House	Somerville, N. J.

Connecticut Savings Bank............New Haven, Conn.
Maryland Institute ....Baltimore, Md.

ALABAMA MARBLE HAS BEEN USED FOR THE INTERIOR OF THE FOLLOWING BUILDINGS

United States Custom House............New York, N. Y.
Western Union Building............New York, N. Y.
Knickerbocker Trust Company............New York, N. Y.
Harriman National Bank (Formerly Night and Day) ....New York, N. Y.
Trust Company of America............New York, N. Y.
Continental Building, 80 Maiden Lane............New York, N. Y.
Common Council Chamber, City Hall............Philadelphia, Pa.
Select Council Chamber, City Hall............Philadelphia, Pa.
Widener Building............Philadelphia, Pa.
Lafayette Building............Philadelphia, Pa.
Wm. Penn Hotel............Pittsburg, Pa.
Harry Davis Theatre............Pittsburg, Pa.
Cosmos Club ....Washington, D. C.
Army and Navy Club............Washington, D. C.
Metropolitan Bank Building............Washington, D. C.
Southern Building ....Washington, D. C.
Marine Bank ....Erie, Pa.
First National Bank............Youngstown, Ohio.
Whitney Building ....Detroit, Mich.
Kresge Building ....Detroit, Mich.
Continental & Commercial Bank Building............Chicago, Ill.
Insurance Exchange Building............Chicago, Ill.
Westminster Building ....Chicago, Ill.
Kesner Building ....Chicago, Ill.
Peoples Gas Building............Chicago, Ill.
Fields Store, Tea Room and Fountain............Chicago, Ill.
Federal Life Building............Chicago, Ill.
University Club ....Chicago, Ill.
Chicago, Burlington & Quincy Building............Chicago, Ill.
Lytton Building ....Chicago, Ill.
New Omaha Grain Exchange Building............Omaha, Neb.
Alworth Building............Duluth, Minn.
First National-Soo Line Building............Minneapolis, Minn.
Northwestern Mutual Life Insurance Bldg............Milwaukee, Wis.
United States Postoffice............Oklahoma City, Okla.
Floors in Oklahoma State Capitol............Oklahoma City, Okla.

Tulsa Hotel	Tulsa, Okla.
Hendricks County Court House	Danville, Ind.
Arkansas State Capitol	Little Rock, Ark.
Pulaski County Court House	Little Rock, Ark.
Thompson-Gregory Building	Hot Springs, Ark.
City Hall Building	Louisville, Ky.
City Hospital	Louisville, Ky.
Commercial Bank Building	Charlotte, N. C.
Durham County Court House	Durham, N. C.
United States Postoffice	Raleigh, N. C.
Healy Building	Atlanta, Ga.
Hurt Building	Atlanta, Ga.
Lowry National Bank—Banking Rooms	Atlanta, Ga.
Georgian Terrace	Atlanta, Ga.
Forsyth Street Theatre Building	Atlanta, Ga.
Dempsey Hotel	Macon, Ga.
Savannah Hotel	Savannah, Ga.
United States Postoffice	Americus, Ga.
Jenkins County Court House	Millen, Ga.
Seminole Hotel	Jacksonville, Fla.
Burbridge Hotel	Jacksonville, Fla.
Windle Hotel	Jacksonville, Fla.
Atlantic National Bank	Jacksonville, Fla.
St. James Building	Jacksonville, Fla.
Florida Life Insurance Building	Jacksonville, Fla.
City Engineering Building	Jacksonville, Fla.
San Carlos Hotel	Pensacola, Fla.
Sacred Heart Hospital	Pensacola, Fla.
Union Station	Pensacola, Fla.
Jefferson County Bank Building	Birmingham, Ala.
Jefferson County Bank—Banking Rooms	Birmingham, Ala.
American Trust Building	Birmingham, Ala.
Brown-Marx Building	Birmingham, Ala.
First National Bank Building	Birmingham, Ala.
Woodward Building	Birmingham, Ala.
Chamber of Commerce Building	Birmingham, Ala.
Lyric Theatre	Birmingham, Ala.
Union Station	Birmingham, Ala.
Jemison Real Estate & Ins. Co.'s Office	Birmingham, Ala.
Noble Theatre Building	Anniston, Ala.
Bell Building	Montgomery, Ala.
Union Station	Montgomery, Ala.

United States Postoffice..........Dothan, Ala.
United States Postoffice..........Talladega, Ala.
United States Postoffice..........Gadsden, Ala.
United States Postoffice..........Greenville, Miss.
Ward Building..........Shreveport, La.
Whitney Central Bank Building..........New Orleans, La.
Benevolent Knights of America Building......New Orleans, La.
Cotton Exchange..........Dallas, Texas.
Commonwealth Banking Room..........Dallas, Texas.
Criminal Court Building..........Dallas, Texas.
Carter Building..........Houston, Texas.
Kress Building..........Houston, Texas.
First National Bank Building..........Wichita Falls, Texas.
First National Bank Building..........Paris, Texas.
Scottish Rite Cathedral..........Galveston, Texas.
Giles County Court House..........Pulaski, Tenn.
Doctors' Office Building..........Nashville, Tenn.
Postoffice..........Hattiesburg, Miss.

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PLATES

PLATE I.

A. Marble from tunnel in Gantt's Quarry. The marble is similar to that seen in Plate I B, but is slightly finer and a little more twinned. Maximum grain size .5 m.m. Grade size between 2 and 3. Magnified 50 diameters.

B. A representative grade of the most used crystalline marble from Gantt's Quarry. Note especially the interlocking character of the crystals and the twinning bands. The crystal in the center of the photograph shows displacement of the twinning bands which are here seen cutting one another at acute angles. The thin section from which this photograph was taken came from about ½ inch below the surface of a slab of marble which had been exposed to continuous weathering for over sixty years, and which shows practically no disintegration or iron stain.

Average maximum grain size is .57 m.m. It thus belongs to grade 3. About 50% of the crystals are twinned and many of them are heavily twinned. Magnified 50 diameters.

A

B

10 MB

PLATE II.

A. Marble from quarry Moretti-Harrah Marble Co. About 50% of the crystals are twinned. Small black areas are iron oxide. Grain size is a little over 3. Magnified 50 diameters.

B. Marble from the Eureka White Marble Co.'s Quarry near Talladega Springs. The thin section from which the photograph was taken has in one portion a band with distinctly elongated crystals. The grain size of this marble is grade 2. Magnified 50 diameters.

A

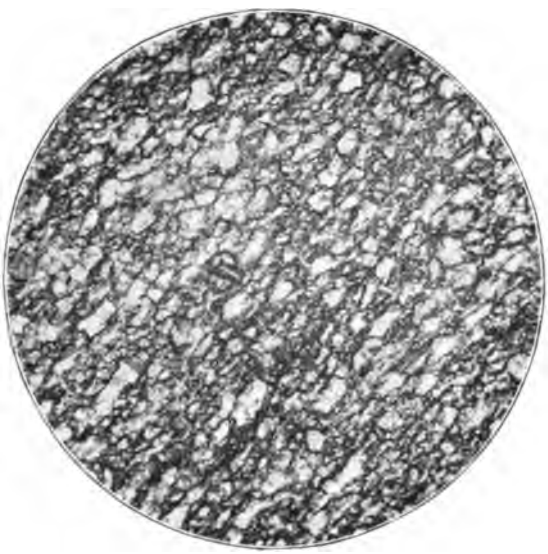
B

PLATE III.

A. Bluish-gray marble from the Alabama Carrara Marble Company's McKenzie Quarry. Average larger grain is about .25 m.m., which throws it into grade 2 in reference to size of grain. The crystals are on an average rather angular. There is also in this marble a tendency for the crystals, which are more or less interlocking, to be elongated. In the lower part of the photograph can be seen a lens of chlorite. Other impurities noted in the slide are the elongated dark areas of iron oxide and an occasional smaller area of quartz. The tendency to elongation in the marble is brought out better in Figure 21. Magnified 50 diameters.

B. Shistose layer of marble from quarry near Taylor's Mill, showing the elongated character of the crystals. This elongation of the crystals causes an easier splitting of the marble in the direction of this elongation. This is the same marble described and figured by both Keith and Van Hise as having come from Talladega Mountain. Average maximum grain .16. Average grain .03. Grain size is therefore less than grade 1. Magnified 50 diameters.

A



B

PLATE IV.

A. Pink variegated marble from near Calera, Shelby County. Larger grains are very angular, (see Fig. 28) and occupy about two-thirds of the space. The remaining area is composed of very fine particles. Occasional twinning in the larger grains is evident under high power. This marble is classed as a semi-crystalline marble.

Average large grain is about .085 m.m., thus giving grain size of less than grade 1. Magnified 50 diameters.

B. Showing banding in less crystalline portion of the variegated marble deposit than that in Plate IV A. Section was cut in a direction perpendicular to the light and dark pink color banding. Maximum grain .03 m.m. Minimum grain .003. Magnified 50 diameters.

A

B

PLATE V.

A. Light blue marble from Tallaseehatchee Creek. This marble while showing a grain size of grade 2 has the crystals much less well defined and twinned than marble from the lighted colored layers. Magnified 50 diameters.

B. So-called "Black Marble" from west of Piedmont, Calhoun County. Average maximum grain is .04 and minimum is too small to measure. Magnified 50 diameters.

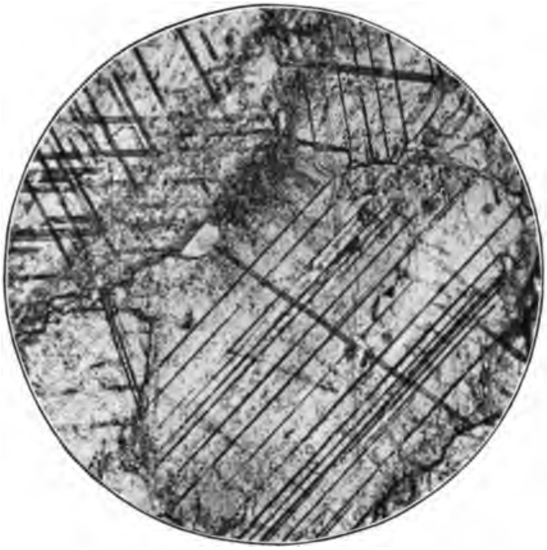
A

B

PLATE VI.

A. Dolomitic marble from Chewacla, Lee County. This marble is almost identical in appearance with the Cockeysville marble of Maryland, which is so much used in that region for building purposes. Grade size 5½. Magnified 50 diameters.

B. Pearly-white, coarse-grained, dolomitic marble from Tallaseehatchee Creek at Louisville and Nashville Railroad bridge. The grain is unusually large. The average maximum grain is 3.3 m. m., and the average minimum grain is 0.3-0.2 m. m., thus making it above grade 6 of table. The crystals are highly twinned and there is a considerable amount of coloring matter along these bands. Occasional small areas of iron stain or stringers of quartz constitute the chief impurity. Twinning bands are distinctly bent by secondary movements of the rock. The white areas represent fractures in the section caused by grinding. In the upper right hand portion of the photomicrograph can be seen twinning bands passing through the shorter diagonal of the cleavage rhombs. This is a characteristic of the mineral dolomite. In calcite the twinning passes through the long direction of the cleavage rhomb. An enlarged sketch of this dolomite twinning is to be seen (Fig. 23). Magnified 50 diameters.



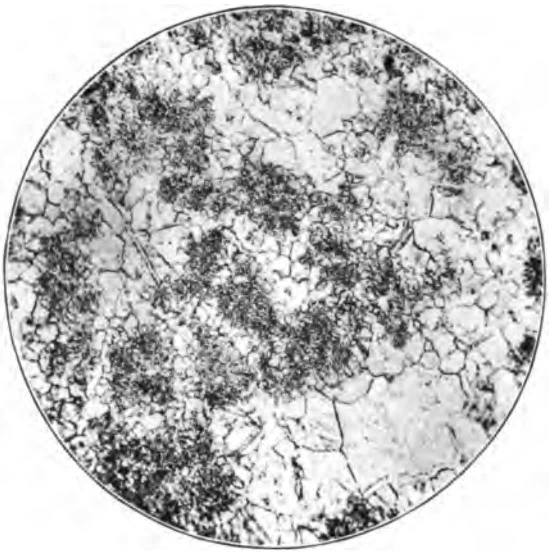
A

B

PLATE VII.

A. Light gray marble from Pratt's Ferry, Bibb County. The semi-crystalline character is well shown by the clouding of finer particles and the scarcity of twinning bands in the crystals. Magnified 50 diameters.

B. Light-gray, Subcarboniferous marble from Tennessee Valley, Morgan County. The grains are of good size, but imperfectly crystalline especially toward the center. Parts of fossils, not yet recrystallized, can be seen here and there throughout the marble. In general appearance this marble very closely resembles the "McMullen Gray" marble of the Tennessee deposits. Magnified 50 diameters.



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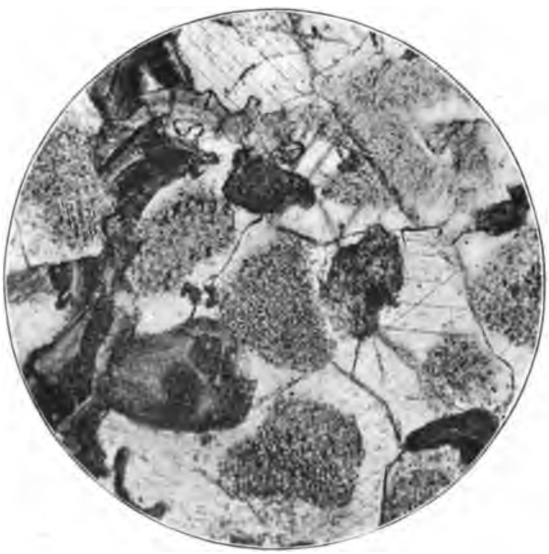
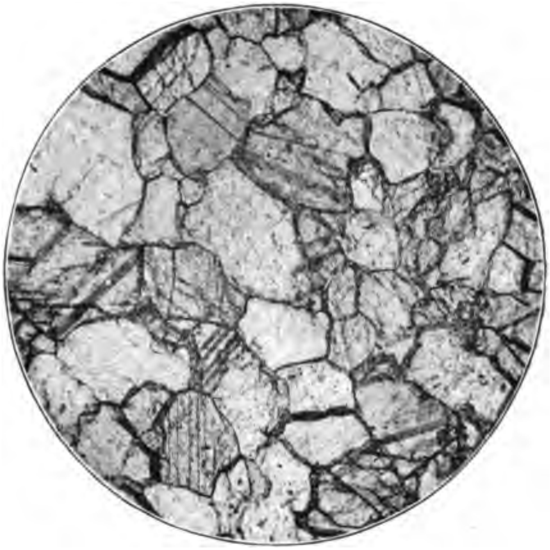


B

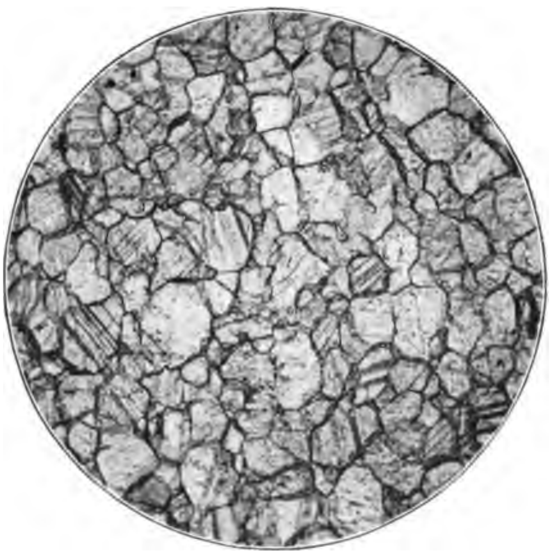
PLATE VIII.

A. Commercial nonsonorous Vermont marble. This specimen is much more regular in the outline of its crystals than any of the Alabama marbles. The photomicrograph explains why many of the Vermont marbles are easier to saw and less resistant to pressure than the Alabama crystalline marble. Magnified 50 diameters.

B. Commercial sonorous, bluish-white Italian marble. The outline of the crystals is less irregular and interlocking than is the case with most of the Alabama marbles. Magnified 50 diameters.



A



B

PLATE IX.

The "Head of Christ," by G. Moretti, was the first notable piece of sculpture ever made in cream-white Alabama marble. It was exhibited at the St. Louis Exposition, where it was awarded a silver medal. The "Head" was greatly admired both for its artistic worth and the beauty of the marble in which it was wrought.

PLATE X.

This life-size stature of "Siegfried" by G. Moretti in cream-white Alabama marble, now on exhibition in Florence, Italy, shows the wonderful possibility of sculpture in this marble.

The rich cream tone is in strong contrast to the bluish tone of much of the Italian statuary marble and is much like some of the famous Grecian statuary marbles.

PLATE XI.

View looking nearly east into the quarry of the Alabama Marble Co., at Gantt's Quarry. Fifteen layers of marble have been utilized in this opening. The dip of the rocks is approximately 36 degrees. The third marble layer from the top was apparently a slipping zone and is marked by solution cavities. The new development tunnels from which, at the present time, practically all the marble for sale is being taken, were put down along this weaker layer. The buildings in the background constitute a portion of the marble finishing plant.

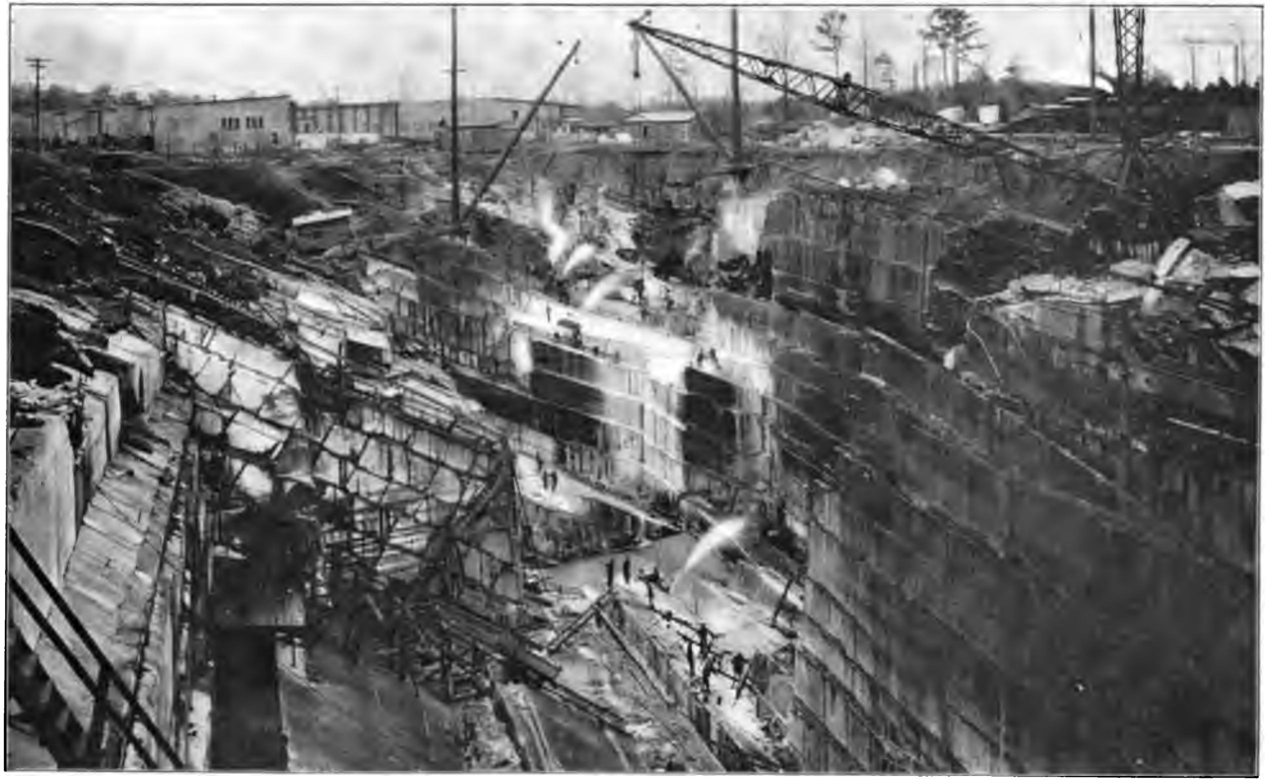


PLATE XII.

View looking nearly west into quarry of Alabama Marble Co. at Gantt's Quarry, showing in the background the former method of quarrying by making the cuts respectively down the slope and at right angles to it. In the foreground can be seen the present method of quarrying diagonal to the strike and dip direction and parallel with the major jointing directions. This method assures a higher percentage of sound marble, since by its use the unsoundness in the quarry block is less likely to pass diagonally through the block.

PLATE XIII.

Showing line of solution in the southeast wall of Gantt's Quarry. Underground waters have been unusually active in this bed (bed 3 from top). It is possible that slipping has taken place between beds 3 and 4, thus affording a plane of weakness for the activity of underground waters. To the left of the picture, can be seen the mouth of one of the development tunnels, of which there are two at the present time. Both tunnels have been driven directly down the slope along the more or less open bed.

PLATE XIV.

Moretti-Harrah Marble Co. Quarry, September, 1914. Shows newly stripped area for extending quarry. Cover here is 6-8 feet thick. On left, wire saw is seen trimming blocks preparatory to their shipment. Studio of G. Moretti in the right background. The opening of the Marble City Quarry Co. is just to the left of this picture. View looking approximately in line of strike. Gantt's Quarry in the distance a little to the left of the studio.

PLATE XV.

Early stage in the development of the Moretti-Harrah Marble Co.'s quarry, showing channelling machine cutting "with the dip." The smoke in the middle background rising above the freight car, is from Gantt's Quarry, three-quarters of a mile distant, diagonally across the marble valley (see map frontispiece for relations).

PLATE XVI.

View from southwest corner of the quarry pit, Moretti-Harrah Marble Co., showing development in fall of 1916.

PLATE XVII.

The opening of the Alabama Marble Quarries Co., about two miles SE of Sycamore. The marble is here in a narrow valley between phyllite hills and has a strike approximately north and south and a dip of about 27 degrees to the east. The marble is covered here from five to eight feet deep and occupies a width of approximately four hundred feet across the strike. In the center background is to be seen the Talladega phyllite hill which bounds the marble on the east. The quarry opening is apparently a little above the center of the deposit from top to bottom. Quarrying is here carried on directly down the dip. A spur track, about 1 miles in length connects the quarry with the Louisville and Nashville Railroad.

PLATE XVIII.

Early development in quarry of the Eureka White Marble Co., about 3 miles south of Talladega Springs. The soil cover is here from 4 to 5 feet in thickness. About a mile southwest of the quarry the marble area is terminated by converging faults.

PLATE XIX.

A. Natural exposure of white marble in a small branch just to the southwest of the quarry of the Eureka White Marble Co. in the SE of the SW of S. 12, T. 24-N., R. 16-E. This is one of the few natural exposures of marble in the area which is not directly due to folding or faulting.

B. Looking from phyllite ridge across narrow marble valley to Herd Quarry. The valley here is repeated by strike faulting and the exposure of marble in Herd Quarry is the result of an uplift of fault-block. Hickman Quarry is back of the camera on west side of phyllite ridge. For probable structure here see Fig. 24.

A

B

PLATE XX.

A. Cliff exposing interbedded, fine-grained, dolomitic marble and phyllite. Rocks of this type occur in a number of places to the west of the crystalline marble area, locally in contact with it and elsewhere separated by a considerable thickness of intervening dolomite. Although the deposits are of no commercial value, they have been in the past considerably prospected.

B. An exposure of a portion of the 25-foot layer of variegated marble which outcrops about 4 miles southeast of Calera, Shelby County, and which belongs to the Montevallo shale and sandstone formation. The ride bearing this marble crosses Buxahatchee Creek in SE of SE of S. 5, T. 24-N., R. 14-E.

A

B

PLATE XXI.

A. Natural outcrop of marble, Nix Old Quarry, one-half mile northeast of the Alabama Marble Quarries in SE of SW of S. 36, T. 19-S., R. 3-E. At this point the Talladega phyllite overlies the marble conformably as far as can be seen. The Nix Quarries of which there are three in the distance of half a mile along this same ridge, were formerly worked on a small scale, but in recent years no development work has been done.

B. Near view of marble broken from ledge in upper part of Nix Quarry. The photograph shows the thin blue banding in the white marble which is a common feature in this portion of the deposit.

A

B

PLATE XXII.

A. Phyllite-marble contact at Hickman Quarry. The marble here exposed immediately underneath the phyllite is apparently the same layer that immediately underlies the phyllite in the Herd Quarry about a quarter of a mile to the southeast across the strike, thus suggesting repetition by strike faulting, Fig. 24.

B. Contact, bottom of marble with underlying phyllite. There is apparent conformity. Pace's Branch near quarry, Alabama Marble Quarries Co., NE S. 1, T. 21-S., R. 4-E.

A

B

PLATE XXIII.

Entrance chamber in onyx-marble cave near Kymulga, Talladega County. The rock in which the cavern is formed is a dolomite. The onyx-marble deposits are calcite.

PLATE XXIV.

A. Interbedded phyllite and dolomitic marble from belt to the northwest of the crystalline marble area. The thin beds of marble have been crumpled while the thicker ones have been fractured and faulted. NE S. 33, T. 21-S., R. 3-E.

B. A mass of dolomite (dark area) enclosed in a beautiful cream-white marble. The bedding planes of the dolomite have entirely different orientation from those of the marble. The interbedded marble and dolomite have been much distributed and mixed by folding, faulting and flowage. Old Bowie Quarry northern portion S. 13, T. 20-S., R. 5-E.

A

B

PLATE XXV.

A. One of the impurities of marble is silica. This mineral is frequently segregated into layers. Sometimes the deformation of the marble is evidenced by the bending of these layers of impurity which could not readily recrystallize. The photograph shows discarded marble blocks containing such evidence of folding.

B. View in one of the two development tunnels in quarry of Alabama Marble Co., (see Plate XIII), showing, near center of picture, one of the two sets of diagonal joints, which constitute the chief unsoundness of the marble. Some of these joints are limited to a single bed while others pass through several.

A

B

PLATE XXVI

A. Folding and reverse faulting in interbedded phyllite and marble from formation west of the crystalline marble belt.

B. The layers of impurities, which mark roughly the position of the bedding plane, are here seen irregularly distributed through the block of marble. This is attributed to drag-folding.

A

B

PLATE XXVII.

A. In the crystalline marble deposits the marble beds are in many places interstratified with dolomite or contain lenses of dolomite, similar to the chief marble deposits of Vermont. Dolomite is less readily recrystallized than calcite and when movements have taken place in the marble beds the dolomite is frequently broken and left in angular fragments or breccia. usually cemented with calcite. A portion of a core which was taken from such a broken dolomite layer is here shown. The dark portion is dolomite and the lighter is calcite.

B. Schistose marble from Upper Leak Quarry, near Taylor's Mill. The schistosity is evidently due to the slipping of one thin layer upon another as the result of shearing stress during the thrust-faulting in this region. The direction of slipping is distinctly seen on the schist planes. A study of thin sections of this rock under the microscope shows a distinct flattening of the crystals of calcite, out of which the marble is made, and also a distinct elongation of these crystal grains in the direction of slipping, (see Plate III B). It is seldom possible to find a specimen of schistosity in marble as good as this and its occurrence at the quarry referred to is restricted to a narrow zone. This is the same marble referred to in Monograph U. S. G. S. No. 47.

A

B

PLATE XXVIII.

Showing common method of keeping marble cores in boxes for future study. Each piece of the core is marked at both ends with progressive numbers as: 1-2, 2-3, 3-4, etc., on the same side of core. The marble shown in this core is for the most part a cream-white with occasional chlorite or talcose clouding or banding. From quarry of Moretti-Harrah Marble Company.

PLATE XXIX.

A. Looking a little east of south from the ridge which runs diagonally across the marble valley through the east side of Sylacauga. The flat bottom lands are largely underlain by marble-bearing rocks. The soil of the bottom lands is chiefly transported, and much of the upper 4-5 feet is a clay suitable for brick-making. The rock is here covered on an average of from 6-9 feet. The view is typical of the wider portion of the marble valley. The Talladega phyllite upland borders the valley on the southeast.

B. The massive chert boulders which can be seen partly hidden by the foliage occur in several places on the western border of the marble belt along the boundary fault. Photograph NW of S. 5, T. 24-N., R. 17-E., E. E. and J. H. Watters' place.

A

B

PLATE XXX.

A. A typical sink in the marble. This one is shallow and has numerous small trees in it. The water collects in this basin after heavy rains, but is not long retained since the water-table is normally several feet below the surface, due to underground stream channels in the limestone. Near opening of Marble City Quarry Co.

B. The photograph shows a stream flowing from Averiett Spring in the dry season. This spring is one of many which flow from the marble area. It comes from the dolomite on the northwest border of the marble and is probable located at the point of crossing of two faults, the one running parallel with the marble and the other coming in more from the north. There are no permanent streams in the marble valley for at least three miles to the northeast, and none in the marble valley to the southwest for a mile and a half. Much of the surface water from this area gets into the underground passages through numerous sinks. Averiett Springs is located in SW of SE S. 6, T. 22-S., R. 3-E.

A

B

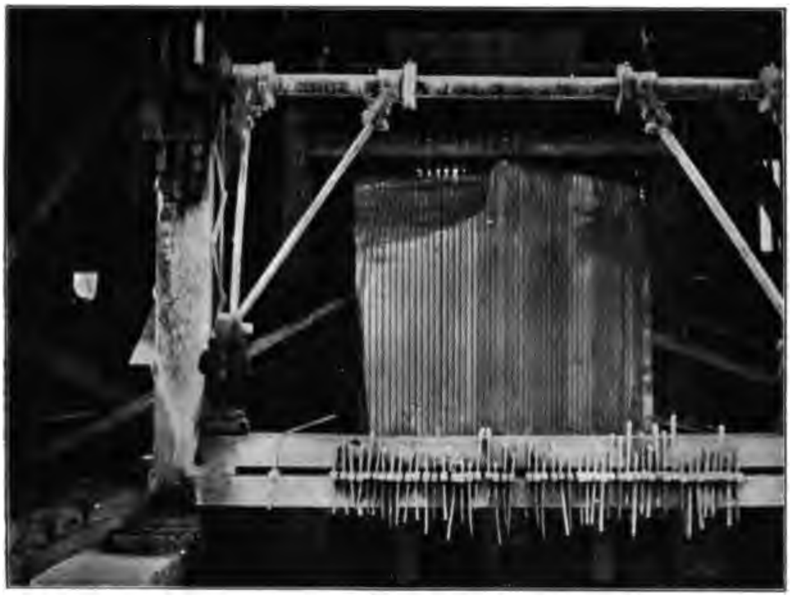
PLATE XXXI.

The marble blocks from the quarry go first to the sheds on the left of the track to be sawed, (Plate XXXII A). The sawed stock is taken by crane across the track to the coping or sizing sheds, in the middle background of picture. From here the marble goes into the main mill on the right, to the rubbing and polishing beds or to the lathe. Alabama Marble Co., Gantt's Quarry, Alabama.

PLATE XXXII.

A. A large percentage of the Alabama marble is used for interior decoration such as wainscoting, and the different varieties of the decorative stone are dependent in no small degree upon the direction in which the stone is cut, whether at a small or a large angle to the direction of the color bands. The block in the photograph has been cut nearly parallel to the color bands so that the yellowish or greenish layers of impurity will appear on the polished face of the marble as cloudings rather than lines. This is one of 19 gangs of saws at the marble mill at Gantt's Quarry.

B. Lathe turning marble column in marble mill at Gantt's Quarry. The marble is placed in the lathe and taken from it by crane through the room.



A

B

PLATE XXXIII.

A. Corner of the finishing plant, showing lathe "roughing in" a cream-white fluted column. Gantt's Quarry.

B. Showing cream-white fluted column segements on finishing tables. Gantt's Quarry.

A

B

PLATE XXXIV.

A view inside the finishing plant of the Alabama Marble Co., Gantt's Quarry. The whole plant is run by electric power and each machine has its individual motor. The arrangement of the finishing plant is such that the marble passes through from the rough to the finished with the least possible handling.

PLATE XXXV.

A large percentage of the smaller dimensional marble from the coping sheds is used for tiling. The view shows the tile storage yards at the Gantt's Quarry finishing plant. There were 150,000 square feet of marble tile in the yard at the time.

PLATE XXXVI.

Mill and a portion of the "McKenzie Blue Quarry" of the Alabama Carrara Marble Co., 4 miles southeast of Talladega. View is looking a little west of south. The steep hill in the background is composed of Talladega phyllite, which is separated from the marble by a thrust fault. Wire saw is made use of in shaping the blocks. The McKenzie White Quarry is about a quarter of a mile to the east, and the Upper Leake Quarry about the same distance to the west of this location. It was from the light blue layers of this quarry that Mr. G. Moretti carved the figures shown at the Jamestown Exposition. Photograph taken in summer of 1911.

PLATE XXXVII.

Main entrance American Trust Building, Birmingham, Ala. Alabama "Pavonazetta' panels and Alabama "Cream A" trimmings.

PLATE XXXVIII.

Interior Jefferson County Bank, Birmingham, Ala. All Alabama marble, including tiling.

PLATE XXXIX.

United States Post Office, Mobile, Alabama. Exterior and interior in Alabama marble.

PLATE XL.

The portico of United States Post Office, Mobile, Alabama, finished in Alabama marble.

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